

Increase exercise adherence in heart failure patients using exergame

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Introduction

Heart failure (HF) could be defined as a cardiac structure anomaly or the heart difficulty to provide oxygen with an appropriate speed commensurate with the metabolic characteristic of the tissues, despite the normal filling pressures. This syndrome behaves typical sign and symptoms in patients. The most common signs are the high jugular pressure, pulmonary crackles and apex beat dislocation, while, among symptoms, there are dyspnea, fatigue and lower limbs swelling. (ESC Guidelines, 2012).

HF can be classified in two different groups: heart failure with reduced ejection fraction (HF-REF) and heart failure with preserved ejection fraction (HF-PEF) (Campbell&McMurray, 2014). The most common is the HF-REF that is found when the left ventricles is dilated and has a reduced systolic function. It is present in about 50% of HF patients, leaving a 50% of HF patients with a normal or preserved ejection fraction. (Castro, in press).

The severity of HF is generally defined by the New York Heart Association classification (NYHA), based on symptomatology and exercise capability.

The HF is the most widespread public health problem. It is estimated that 23 million of patients are affected. (Belardinelli et al., 2012).

Being associated to frequent hospitalizations (Riegel et al., 2009; Adamson, 2013), it is a disease with elevated human and economic costs (Jencks et al., 2009). The costs related to HF amount between 1,1% and 1,9% of total health expenditure in industrialized countries and that the 50-74% of the HF costs are due to hospitalizations and prolonged cares. (Liao et al., 2008).

Data from international studies reports that incidence and prevalence of HF increase with the age: in patients with less than 65 years, the incidence per year is 1/1000 in male HF patients and 0,4/1000 in female HF patients; after 65 years the incidence per year is 11/1000 in male HF patients and 5/1000 in female HF patients; the prevalence before 65 years is 1/1000 for both, while after 65 years is 40/1000 in male HF patients and 30/1000 in female HF patients (Sistema Nazionale Linee Guida-Regione Toscana, 2012).

The reduced exercise tolerance is one of the symptoms most referred by HF patients because, very often, it deeply affect the quality of life.

In HF patients, the cardiac mechanisms, that allow to considerably improve the cardiac output in healthy people, are less efficient. In such hemodynamic condition, the heart needs to increase the tele-diastolic volume also during the rest, as mechanism of compensation. Moreover, there is also an increase of peripheral vascular resistance caused by neuro-hormonal vasoconstrictor mechanisms and adrenergic sympathetic system.

The drug therapy in HF patients usually includes ACEi, diuretics, beta-blockers, ARBs, cardiac glycosides, vasodilators, anticoagulants and antiarrhythmic agents (Sistema Nazionale Linee Guida-Regione Toscana, 2012). These improve the cardiac functioning, reduce the mortality but do not determine any improvement in exercise tolerance. For this reason, it is important to use complementary intervention to reduce the symptomatology. Rehabilitation programs that include supervised exercise trainings in HF patients could be useful for this proposal (Perkan et al., 2004).

This review underlines the important role of exercise in HF patients, particularly by alternative strategy that could allow to reach an higher adherence. Among them, the exergames represent a useful method to reduce some barriers that can obstacle the exercise adherence in these patients. Usually under the term "exergames" are included interactive games that combine a multimedia element like TV, PC, console with devices like joystick, joypad, footboard, headphones, viewer in the effort to reproduce in video a real movement or exercise in a realistic scenario. This is what is defined as augmented reality or virtual reality. Such technology has been used for years both for training and teaching in aeronautics and generally military fields.

Methods

A review was conducted using the main international databases: Pubmed, Cochrane and Embase. Using the key words related to exergame, exercise and heart failure, only 2 articles have been found. To reach a wider

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result, the key words related to the heart failure were deleted, trying to underline the importance of exergame use to improve exercise adherence in all chronic disease.

From this, 63 articles were obtained and 23 of them were taken into account for this review. Articles that were not appropriate for the argument of this study were excluded.

Results

Thirty years ago, the use of rehabilitation programs that included exercise training was not advised because there were the fear of possible worsening in clinical conditions. The common advice suggested periods of rest, while the potential effects of exercise training raised only some years after (Keteyian, 2011).

In 50's US cardiologists started the first rehabilitation programs in patients with cardiac ischemia. Between 60' and 70's, the ambulatories or coronary rehabilitation developed rehabilitation programs both in Europe and in US (Hollmann, 2000). At that time the cardiac rehabilitation was contraindicated in HF patients mainly for the fatal risk of arrhythmia of acute left ventricular failure. The first studies on exercise in HF patients were published in the first '90 (Coats et al., 1990; Sullivan et al., 1989) and nowadays these patients participate to cardiac rehabilitation programs in every part of the world (Delagardelle et al., 2005).

At today, several studies reported that the exercise is related to an improvement of functional capability and quality of life in HF patients. Although, many physician are still uncertain and wary about the methodology and the safety in exercise rehabilitation programs in HF patients. (Smart&Marwick, 2004).

Many studies reported how the exercise, structural or at home, is safe and creates benefits for HF patients, reducing mortality and rehospitalization in patients with moderate or high severity in symptoms (ESC Guidelines, 2012; Conraads et al., 2012). Results from ExTraMatch review suggest that patients randomized in an exercise intervention group have a better prognosis (Piepoli et al., 2004). These results were confirmed by HF-ACTION protocol that demonstrated improvement in physical capability and a reduction in mortality for all causes in patients physically active (Flynn et al., 2009). The main limit in HF-ACTION study was the poor adherence in prescribed exercise, with only 30% of patients that adhered to the advices after 3 years.

Generally, the exercise adherence in HF patients is low and this could affect the standard treatments effect on clinical outcomes, as rehospitalization and mortality (Conraads et al., 2012; Leventhal et al, 2005; Tierney et al., 2011). Many factors could influence the adherence level to the self-care in general, and some of them influence the exercise adherence. The self-efficacy and the motivation are important aspects in being and keeping physically active, as well as to overcome the natural barriers to adherence. (Dzewaltowski, 1989; Stenstrom et al., 1997).

To increase the level of exercise adherence in HF patients, it is needed tailored system of alternative approach to motivate adequately the patients. Recent studies aimed to the exergame role in exercise, as instrument to increase the exercise adherence, demonstrated how there is a steady growth and a positive development toward the technology involvement in medical treatments, mainly toward the chronic disease. Many ludic interventions have been tested to stimulate the exercise adherence (28%), including among them the exergames (Kharrazi et al, 2012). The exergame term is usually used to define the combination of videoludic dimension with the exercise. Particularly, it is a videogame category where the interaction is not only based on the eyehand coordination, but including the whole body (Di Tore et al., 2012).

A meta-analysis, aimed to evaluate the energy expenditure using exergames, reported that they are able to increase the cardiac frequency, the peak of O2 consumption and the calories consumption compared with the inactivity, facilitating the exercise promotion at moderate and/or light level (Peng et al, 2011). The exergames could represent a valid option for HF patients to keep them active, increasing their exercise adherence, mainly at home, pushing them to be more active, especially for who is reluctant toward the traditional types of exercise, as to go to the gym, or take a walk outside their home. However, until today, most of the studies conducted with exergames on adults with systemic disabilities mainly included patients affected by stroke (Plow et al., 2011).

At first, a longitudinal observational study on a single patient with HF was conducted using exergames (Verheijden Klompstra et al., 2013). This study underlined how providing a structured access to a videogame could be an effective and safe intervention to promote the exercise adherence in this kind of patients. This is reachable because its use lead to an increase in energy expenditure, and consequentially to an increase in physical capability. Moreover, it is suggested that the ludic component does not increase the physical effort perception, but increases the motivation and reduces the barriers to be physical active.

This aim pushed, before by a pilot study, and after by an international multicentric protocol, the Linkoping University to promote the HF-Wii study. (Klompstra et al., 2014; Jaarsma et al., 2015). The pilot study included 32 HF patients with a NYHA class between II and III, with a mean age of 63 years.

The HF-Wii study is a multicentric international RCT that involved, among others, an Italian center for HF patients recruitment in the "Casa di Cura Villa delle Querce" hospital (Nemi – Rome) in its cardio-pulmonary rehabilitation ward.



This study try to discover how the exergame (Wii console) could increase the level of physical capability in HF patients at home, compared with a control group. Among the secondary endpoints there are the effects of this intervention on quality of life, mortality and rehospitalization, motivation to exercise, self-efficacy, anxiety and depression, HF symptomatology (Jaarsma et al., 2015).

Discussion

The guideline for HF treatment suggested, among all interventions, the regular exercise, if possible following structured programs tailored to the preferences and physical capability of each patients. This activity lead to an improvement of physical capability and quality of life, without affecting the left ventricle functionality, reducing the mortality and rehospitalization in patients with HF from light to moderate (McMurray et al., 2012).

The exergame use, as a further motivational support to the exercise is safe and feasible in different studies, without reporting cases of related adverse effects. After a structured training session, leaving the patients to familiarize with the consoles, there were no problems in their use by stroke patients (Saposnik et al., 2010). In a study that included aged women, there were no troubles in exergame use (Nintendo Wii), reporting how the console mastery was one of the most important factors after the choice of the favorite game to play (Wollersheim et al., 2010). Moreover, it is reported a good level of adherence in exergame use, from 84% to 98% (Maillot at al., 2011; Rosenberg et al., 2010; Saposnik et al., 2010).

From international literature, the exergame use is generally related to an increase in daily energy expenditure if compared with the rest or the use of videogames that not include any body movement (Taylor et al., 2012). There were no differences in exergame use (playing bowling or boxing) standing or sitting, or comparing different kind of consoles. Furthermore, it is possible to state that the energy expenditure by the exergame is similar to a light to moderate physical activity (Maillot et al., 2011; Taylor et al., 2012).

Some games, as the cybercycling, could provide a virtual competitor that increase the physical effort stimulating the individual competition (Anderson-Hanley et al., 2011). Cardiac patients, that attend rehabilitation programs with cyberwalking, have a higher workload and require a less number of training session to reach the maximum peak of oxygen consumption and heart rate, compared with who follow a rehabilitation program based on treadmill (Chuang et al., 2006).

Also the cognitive function seems to receive some benefits from this type of rehabilitation programs, for both the executive functions and speed of elaboration (Maillot et al., 2011). The cybercycling allow to reach better cognitive function compared with traditional exercise, with the same level of physical effort. (Anderson-Hanley et al., 2012).

The followers of a rehabilitation program with the exergame use report a positive approach, often accompanied with a desire to continue with such methodology (Agmon et al., 2011; Maillot et al., 2011; Rand et al., 2008). In literature there are no differences related to age or gender. Moreover, it is reported a reduction of depressive symptoms and an increase of mental quality of life and of the empowerment (Rosenberg et al., 2010; Wollersheim et al., 2010). Benefits related to an easier movement capability and to a psychosocial well-being were reported. Within the familiar environment, the exergames allow ludic and sharing experiences, keeping the patients connected with their family members, especially with their nephew.

Conclusion

Although the research about the exergame use to enhance exercise adherence is developing, it is possible to state that the console use could be a safe and effective alternative, able to facilitate the rehabilitation programs in many chronic disease, especially for those that have a greater benefit from regular exercise.

The benefits due to the console use cannot be attributed only to the possibility to have an alternative to home exercise in rehabilitation process, but also to the important role as facilitator to break down the barriers arising from social isolation, allowing to involve the family and the caregivers.

From the review conducted, it is important to underline how it is possible to find more strategies of intervention in rehabilitation health policy, mostly if these aim to increase the level of adherence to exercise, especially for those patients affected by chronic disease that not tolerate the physical effort, as the heart failure.