Respiratory Medicine (2014) 108, 1516–1524

Available online at www.sciencedirect.com

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journal homepage: www.elsevier.com/locate/rmed

Interactive videogame as rehabilitation tool of patients with chronic respiratory diseases: Preliminary results of a feasibility study

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Received 22 May 2014; accepted 7 July 2014
Available online 16 July 2014

KEYWORDS
Rehabilitation;
Pulmonary disease;
Interactive videogame;
COPD;
Health related quality of life;
Dyspnea

Summary
Objective: To evaluate the effectiveness of an interactive videogame (IV) system in addition to a supervised pulmonary rehabilitation programme (PRP) in patients with chronic respiratory diseases.
Design: Randomised Controlled Trial comparing standard PRP (20 patients, control group: CG), and PRP + sessions of interactive videogame-aided exercises (20 patients, experimental group: EG). Lung and respiratory muscle function, arterial blood gases, exercise capacity, dyspnoea, health status and health-related quality of life (HRQL) and emotional response were measured before and after PRP. A questionnaire on acceptability of the PRP was administered.
Results: Exercise capacity, dyspnoea and HRQL significantly improved in both groups after the PRP, whereas the EG showed a greater improvement in six-minute walk test and transitional dyspnoea index than the CG. No difference in psychological status or acceptability of PRP was observed between the two groups.
Conclusions: The addition of IV training was more effective for improving some parameters of exercise tolerance and dyspnoea, although did not result in better psychological status nor it was better accepted than the standard PRP in patients with chronic respiratory diseases.

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http://dx.doi.org/10.1016/j.rmed.2014.07.004
0954-6111/

Introduction

Pulmonary rehabilitation is recognised as a core component of the comprehensive management of patients with chronic obstructive pulmonary disease (COPD) and other chronic respiratory diseases [1]. After rehabilitation patients report improvements in health-related quality of life (HRQL), relief of respiratory symptoms, increase in exercise tolerance and ability to perform daily living activities and a greater independence [2,3].

The use of interactive games is rapidly increasing in physical therapy and sports medicine facilities [4–8]. The growing popularity of computer gaming is partially due to the belief that playing interactive videogames (IV) during a rehabilitation session can direct the patient's attention away from the repetitive nature of rehabilitation exercises and toward the pleasure and competitive aspects of videogames [9,10]. The Wii Balance Board™ (Nintendo of America Inc, Redmond, WA, USA), an additional device of Nintendo Wii, has characteristics similar to a force plate and contains transducers used to assess force distribution and the subsequent movements of an individual's centre of pressure [9,10]. Thus, the Wii Balance Board™ combines current force-platform technology with the amusement value of gaming while completing fitness activities. Many studies demonstrated the validity and effectiveness of the Wii Balance Board™ as a balance training intervention tool [11,12]. Preliminary findings have indicated also that the IV system may be applied to rehabilitation of balance deficits [13], particularly in patients with Parkinson disease [14], and upper extremity control of individuals post-stroke [15].

Few uncontrolled studies analysed the feasibility and acceptability of virtual game systems as a tool of pulmonary rehabilitation programs (PRP) in COPD patients [8,16]. On the best of our knowledge no controlled studies evaluating the effectiveness of videogames systems are available so far. Therefore, the aim of the present randomised controlled study was to evaluate the feasibility and effectiveness of IV system in addition to a supervised standard PRP in patients with COPD and other respiratory diseases. We hypothesised that adding a short period of IV training would result in additional benefits, compared to PRP only.

Methods

Patients

The protocol was approved by the Ethical Committee of University Hospital, Pisa (Italy), (approval n. 3472) informed consensus was signed by all patients. Patients recovering from an exacerbation of their chronic respiratory disease requiring acute care hospital admission and transferred to the Pulmonary Rehabilitation Unit of Auxilium Vitae Rehabilitation Center, Volterra, Italy to undergo a PRP were studied from May 2012 to August 2013. In patient PRP is the rehabilitation modality in Italy; thus, patients usually move to rehabilitation centre after discharge from acute care hospitals as described elsewhere [17,18]. In all cases referral to PRP was within 10 days following the acute care. At admission to PRP all patients had stopped smoking, were in stable conditions, as assessed by absence of worsening in symptoms, as defined by a change in the patient's baseline dyspnoea, cough and/or sputum beyond day-to-day variability sufficient to warrant a change in management, stability in blood gas values (no substantial changes in arterial blood gases). Patients unable to cooperate were excluded from the study. All patients received regular treatment as appropriate according to current guidelines for their diseases [1].

Patients with (a) co-existing motor limitations (e.g. neuro-muscular diseases); (b) other associated severe clinical conditions (i.e. unstable angina, advanced chronic heart failure), which may have limited or impaired response to training; and (c) lack of uptake of procedure and adherence, were also excluded from the study.

Anthropometric, demographic and clinical characteristics of patients are shown in Table 1. Patients of both groups were comparable for general characteristics.

Pulmonary rehabilitation program

Patients were randomized either to a standard 3 week supervised PRP (control group, **CG**) or the same 3-week PRP with the addition of 7 daily sessions of exercises with Wii Fit Plus™ (experimental group, **EG**) (Fig. 1).

Patients of both groups participated in a multidisciplinary, 15- to 21-day, in-hospital PRP that included the optimisation of drug therapy and daily sessions of:

1) supervised incremental exercises on a treadmill, a cycle, and an arm ergometer according to the protocol suggested by Maltais et al. [19] until the achievement of

Table 1 Demographic, anthropometric and physiological characteristics of the patients at admission.

	EG ($n = 20$)	CG ($n = 20$)	p
Age, years	68.9 ± 11.0	73.5 ± 9.2	0.156
BMI	25.8 ± 6.3	26.2 ± 6.20	0.821
COPD, *n*	13	11	0.747
ILD, *n*	4	3	1.000
Asthma, *n*	1	2	0.963
Bronchiectasis, *n*	1	1	1.000
RCD, *n*	1	3	0.598
FVC, %pred	95.4 ± 22.1	91.0 ± 21.6	0.576
FEV1/FVC, %	56.2 ± 17.2	52.7 ± 20.5	0.604
FEV1, %pred	66.3 ± 19.3	59.7 ± 25.7	0.416
RV, %pred	105.9 ± 46.0	111.9 ± 50.1	0.794
TLC, %pred	95.9 ± 26.5	99.2 ± 29.3	0.804
PaO_2/FiO_2	286.9 ± 63.5	298.1 ± 39.6	0.515
$PaCO_2$, mm Hg	44.6 ± 8.2	43.4 ± 6.2	0.621
pH	7.41 ± 0.04	7.42 ± 0.03	0.296
BDI	3.9 ± 1.5	3.5 ± 1.9	0.474

BMI, body mass index; COPD, chronic obstructive pulmonary disease; ILD, interstitial lung disease; RCD, restrictive chest wall disease; FVC, forced vital capacity; FEV1, forced expiratory volume in 1 s; RV, residual volume; TLC, total lung capacity; PaO_2, arterial oxygen tension; FiO_2, inspiratory oxygen fraction; $PaCO_2$, arterial carbon dioxide tension; pH, arterial pH; BDI, baseline dyspnea index.