Applied Nursing Research 43 (2018) 75–79

Contents lists available at ScienceDirect

Applied Nursing Research

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

Original article

Adherence to home-based inspiratory muscle training in individuals with chronic obstructive pulmonary disease

Dorthe Sørensen*, Helle Svenningsen

Department of Research in Rehabilitation and Health Promotion, Faculty of Health Science, VIA University College, Hedeager 2, DK-8200 Aarhus, Denmark

ARTICLE INFO

Keywords:
Borg Category Ratio Scale of Perceived Exertion
Internet-based feedback
Mechanical threshold loading
Non-adherence
Pulmonary rehabilitation

ABSTRACT

Background: Chronic obstructive pulmonary disease (COPD) is an incurable progressive illness characterized by airflow limitation and respiratory failure. Inspiratory muscle training (IMT) combined with pulmonary rehabilitation increases inspiratory muscle strength and endurance, and it decreases dyspnoea. Little is known about IMT adherence, and in the present study, we aimed to evaluate adherence to home-based IMT used with automatic internet-based feedback, in patients with chronic obstructive pulmonary disease.

Method: The adherence was evaluated at an individual level by completing a before-and-after comparison between two groups. Over a 12-week study period, the participants performed two daily sessions of 30 breaths with a mechanical threshold loading training device. They were randomly assigned to either a group of people who self-reported their perceived exertion during breathing and who received automatic internet-based feedback regarding their next threshold loadings, or a group of people who performed IMT with 30% maximal inspiratory pressure and who received no feedback.

Results: The group of patients who self-reported their perceived exertion showed significantly better training adherence compared with the group of patients who received no feedback.

Conclusion: Adherence was greater among patients who self-reported their perceived breathing exertion and received automatic internet-based feedback on the next threshold loadings compared with patients who self-reported training sessions without feedback.

1. Introduction

Chronic obstructive pulmonary disease (COPD) is an incurable progressive illness characterized by airflow limitation and respiratory failure (Vogelmeier et al., 2017). It is also associated with a negative influence on respiratory muscle strength (Hamilton, Killian, Summers, & Jones, 1995) and contributions to hypercapnia (Bégin & Grassino, 1991), dyspnoea and reduced exercise capacity (Gosselink, Troosters, & Decramer, 1996). During exercise training, the diaphragms of patients with COPD are forced to work harder (Sinderby et al., 2001), and these patients use a larger percentage of the maximal inspiratory pressure (PI,max) compared with healthy people (O'Donnell, Bertley, Chau, & Webb, 1997).

A meta-analysis demonstrated that inspiratory muscle training (IMT) combined with pulmonary rehabilitation increases inspiratory muscle strength and endurance, and it decreases dyspnoea (Gosselink et al., 2011). However, adherence to IMT interventions is poor, possibly due to the requirement of two daily 15-minute sessions. Langer et al. (2015) recently completed a randomised controlled trial of a novel IMT intervention in patients with COPD. The tested intervention involved two daily IMT sessions of 30 breaths each, using a newly developed breathing trainer device that applies electronic variable threshold resistance training (POWERbreathe International Ltd., 2018). This reduced the daily training time to only 5–6 min. Although multiple factors influence training adherence (Blackstock, ZuWallack, Nici, & Lareau, 2016; Blasi, Raddi, & Miravitlles, 2015; Bourbeau & Bartlett, 2008), it is expected that shorter training times positively affect adherence, so a training requiring a daily training time of 5–6 min is a promising alternative to traditional IMT requiring two daily 15-minute sessions (Langer et al., 2015).

Although little is known about IMT adherence, it is also expected that breathing trainer devices using electronic variable threshold resistance training positively impact the adherence to IMT (Charususin et al., 2013). Unfortunately, electronic breathing trainer devices, such

Abbreviations: IMT, inspiratory muscle training; MTL, mechanical threshold loadings

* Corresponding author.
E-mail addresses: DSOR@via.dk, @dsor_srensen8 (D. Sørensen).
URLS: https://dk.linkedin.com/in/dorthesorensen1 (D. Sørensen), https://dk.linkedin.com/in/helle-svenningsen-05021959 (H. Svenningsen).

https://doi.org/10.1016/j.apnr.2018.07.005
Received 13 December 2017; Received in revised form 29 June 2018; Accepted 25 July 2018

as the POWERbreathe K series, which automatically adapts to training requirements, are significantly more expensive (250–550 euro) than breathing trainers with mechanical threshold loadings (MTL). MTL is a flow-independent one-way valve (Philips Threshold, 2018; YouTube racheeze22, 2018). It is probably not possible to use such an expensive self-purchased breathing trainer device for home-based IMT in patients with COPD (Grigsby et al., 2016). Breathing trainers with MTL cost about one-tenth of the price of electronic breathing trainer devices and are thus a more realistic option for at-home training based solely on price.

Previous studies mainly focused on the effects of IMT. In the present study, we aimed to prospectively evaluate adherence to home-based MTL IMT used with automatic internet-based feedback (automatic feedback) based on COPD participants' effort scores, as an alternative to more expensive electronic breathing trainer devices. The IMT involved two daily sessions of 30 breaths each.

2. Materials and methods

2.1. Study design

In this study, we prospectively evaluated adherence to 12-week home-based IMT using an MTL breathing trainer device combined with automatic feedback, initiated after the completion of a pulmonary rehabilitation program at a municipal outpatient clinic in Denmark. The mechanical threshold loadings were determined based on the participants' self-reported effort scores as well as automatic feedback. Adherence was evaluated at an individual level by completing a before-and-after comparison between two groups.

The study complied with the guidelines of the Declaration of Helsinki for Human Experimentation and received approval from the Danish Data Protection Agency (Jnr.2014-41-3587). Based on Danish law and on the study design, neither approval from the national ethics committee nor registration at ClinicalTrials.gov was necessary. Questionnaire surveys are only to be notified if the project involves a study of human biological material or is a clinical trial (Region Midt, 2018).

The pulmonary rehabilitation program ran for six weeks. Twelve two-hour sessions were held, including psychological counselling, nutritional counselling, education on COPD management, energy-conserving techniques and breathing strategies. Healthcare professionals hosted these sessions (i.e. physiotherapists, a pulmonologist, an occupational therapist, a dietician and a respiratory nurse). During the pulmonary rehabilitation program, the physiotherapists obtained data for each participant, including his or her gender, age, body mass index, marital and work statuses, six-minute walk test (6MWT) data (Brown & Wise, 2007) and spirometry (forced expired volume in the first second) (Vogelmeier et al., 2017). Moreover, during this programme, all participants were introduced to the Borg Category Ratio Scale of Perceived Exertion (Borg Scale) (Hastrup & Hove, 2008; Mador, Rodis, & Magalang, 1995) (Fig. 2).

Study participants were recruited from three pulmonary rehabilitation courses between January and July of 2015. The target group included patients with mild to moderate COPD to whom their general practitioners had prescribed pulmonary rehabilitation. To participate in the evaluation internet access via a computer, tablet or smartphone, the following were necessary: a PI,max equal to or less than the mean predicted PI,max for the person's gender and age group (Rochester & Arora, 1983), and a willingness to participate. A physiotherapist measured the PI,max (O'Donnell et al., 1997) using a POWERbreathe KH1. Exclusion criteria included cognitive, neurological, neuromuscular or orthopaedic problems, as well as the inability to speak Danish. The physiotherapist distributed eligible participants to two groups, and the participants were blinded to the researchers.

2.2. Home-based IMT with or without feedback

Physiotherapists individually trained all of the participants on how to perform IMT with the MTL breathing trainer device, which involved inspiration against a mechanical threshold and unimpeded expiration. The participants were instructed to train twice each day (morning and evening), performing 30 breaths in each session, for a total of 12 weeks as in the study of Langer (Langer et al., 2015). Thus, each participant performed a maximum of 168 IMT sessions. Participants were instructed to log their IMT sessions depending on the group to which they were randomised. Delivering the individual instructions took about 15 min per participant, and the same physiotherapist delivered them throughout the study. The participants had no contact with the healthcare professionals from the outpatient clinic during the 12-week study period. We pre-specified the criteria for success to be the completion of at least 70% of the total IMT sessions.

In one group, home-based MTL IMT was executed with the highest tolerable PI,max. Participants self-reported their perceived exertion in breathing using the Borg Scale, entering this information on a homepage with a responsive Web design, on which the Borg Scale was illustrated. The software (SurveyXact) used was 100% Web based. After entering their numbers, participants received automatic feedback proposing their next IMT threshold levels. The feedback was intended to encourage a perceived IMT intensity level of 3–7 on the Borg Scale. If the participant's perceived Borg Scale score was < 4, he or she was encouraged to increase his or her threshold loading by 2 cm H_2O. If the perceived Borg Scale score was > 7, feedback was provided to reduce the threshold loading by 2 cm H_2O. Data on Borg Scale was not recorded.

In the other group, home-based IMT was executed using 30% of PI,max without the self-reporting of effort scores on the Borg Scale without feedback. Participants in the second group were not instructed to change their threshold loadings on their breathing trainer devices, and they self-reported their numbers of daily IMT sessions in paper diaries.

2.3. Evaluation

The final data for this evaluation included: adherence to IMT sessions, threshold loadings, PI,max and the 6MWT performed in a 15-meter indoor gym hall and allowing the use of all kinds of walking aids. The physiotherapist and the research team performed all measurements at the municipal outpatient clinic.

To assess the comparability between the groups, we used Fisher's exact probability test to analyse categorical data, and the Kruskal-Wallis equality-of-populations rank test. To test for likelihood, we used the Wilcoxon signed-rank test to compare non-parametric data. We used a paired *t*-test to estimate the difference between pre-evaluation and post-evaluation assessments.

All included participants were invited to participate in a qualitative interview to further explore adherence to home-based MTL IMT. The interviews included questions regarding the participants' actions, experiences, concerns, and attitudes towards the training. We report the detailed findings from these interviews elsewhere (article in progress).

3. Results

We recruited 47 prospective participants, of whom 36 were eligible for participation and 27 completed the evaluation (Fig. 1). The group with feedback (n = 17) and the group with no feedback (n = 19) were comparable with regards to baseline characteristics, including gender, age, marital status, spirometry, body mass index, pre-evaluation PI,max, 6MWT and dropout rates (Table 1, “Baseline Characteristics of Possible Participants”).

Of the 11 excluded participants, two did not wish to participate, and nine had no access to the internet or had mean PI,max's of above the