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Pulmonary rehabilitation programs for patients with COPD*

Programas de reabilitação pulmonar em pacientes com DPOC

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Abstract

Pulmonary rehabilitation programs are aimed at providing benefits to COPD patients, in various aspects. Our objective was to review the literature on COPD patient rehabilitation. This systematic review involved articles written in English, Spanish, or Portuguese; published between 2005 and 2009; and indexed in national and international databases. Articles were classified in accordance with the Global Initiative for Chronic Obstructive Lung Disease criteria for the determination of the level of scientific evidence (grade of recommendation A, B, or C). The outcome measures were exercise, quality of life, symptoms, exacerbations, mortality, and pulmonary function. Treatments were classified as standard rehabilitation, partial rehabilitation, strength exercises, and resistance exercises. Of the 40 articles selected, 4, 18, and 18 were classified as grades A, B, and C, respectively. Of the 181 analyses made in these articles, 61, 50, 23, 23, 20, and 4, respectively, were related to the outcome measures quality of life, exercise, symptoms, exacerbations, pulmonary function, and mortality. The standard rehabilitation programs showed positive effects on all of the outcomes evaluated, except for mortality (because of the small number of analyses). However, we found no differences among the various rehabilitation programs regarding their effects on the outcomes studied. Rehabilitation programs can be considered important tools for the treatment of COPD. Therefore, health administrators should implement public policies including such programs in the routine of health care facilities.

Keywords: Rehabilitation; Pulmonary disease, chronic obstructive; Review.

Resumo

Programas de reabilitação pulmonar visam à melhora do paciente com DPOC em vários aspectos. Esta revisão teve como objetivo avaliar a literatura sobre reabilitação em pacientes com DPOC. Foi realizada uma revisão sistemática incluindo artigos publicados entre 2005 e 2009, indexados em bases de dados nacionais e internacionais e escritos em inglês, espanhol ou português. Os artigos foram classificados segundo o critério da *Global Initiative for Chronic Obstructive Lung Disease* para nível de evidência científica (grau de recomendação A, B e C). Os desfechos exercício, qualidade de vida, sintomas, exacerbações, mortalidade e função pulmonar foram pesquisados. Os tratamentos foram classificados como reabilitação padrão, reabilitação parcial, exercícios de força e exercícios de resistência. Dos 40 artigos selecionados, 4, 18 e 18 foram classificados com graus A, B e C, respectivamente. Das 181 análises oriundas desses artigos, 61, 50, 23, 23, 20 e 4, respectivamente, foram relacionadas aos desfechos qualidade de vida, exercício, sintomas, exacerbação, função pulmonar e mortalidade. Em todos os desfechos avaliados, os programas de reabilitação padrão tiveram efeitos positivos sobre os desfechos estudados, exceto para mortalidade pelo reduzido número de análises. Entretanto, não foram verificadas diferenças nos efeitos sobre os desfechos estudados quando os diferentes programas de reabilitação foram comparados. Programas de reabilitação pulmonar podem ser considerados importantes ferramentas no arsenal do tratamento da DPOC, merecendo atenção dos gestores em saúde para a implementação de políticas públicas que os incluam como rotina nos serviços de saúde.

Descritores: Reabilitação; Doença pulmonar obstrutiva crônica; Revisão.

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Introduction

In recent years, the prevalence of respiratory diseases has increased substantially, and respiratory diseases have come to play a major role in the morbidity and mortality profiles of the population.⁽¹⁾ Among chronic respiratory diseases, COPD is the most common. A public health problem, COPD ranked fourth among the leading causes of death worldwide in 2006.⁽²⁾ According to the World Bank, by 2020, COPD will have the fifth leading “disease burden” worldwide. Irreversible or partially reversible bronchial obstruction accompanies COPD. This obstruction manifests as various symptoms, among which are dyspnea and limited ability to perform physical activities. Treatment, pharmacological or otherwise, is extremely important for patients with COPD. In this sense, pulmonary rehabilitation of patients with COPD has emerged as a standard recommendation among the nonpharmacological treatments.

⁽¹⁾ The habitual objectives of a pulmonary rehabilitation program include improvement in the symptoms of the disease, improvement in the quality of life of patients, and physical improvement of patients in order to restore their ability to perform their activities of daily living.^(2,3) In addition, pulmonary rehabilitation programs address problems such as poor physical conditioning, muscle mass loss, and weight loss.

⁽²⁾ Improvement in any of those aspects can have a positive effect on the prognosis of the disease. Studies have reported an increase in knowledge regarding rehabilitation, principally in the last decade.^(1,4,5) It is of note that a pulmonary rehabilitation program can be applied in various circumstances, treatment heterogeneity having been reported in the literature. A careful evaluation of the scientific literature on the theme can aid in overcoming skepticism and in convincing pulmonary rehabilitation and respiratory care professionals, as well as health institutions and regulatory agencies, to invest in rehabilitation programs.⁽⁵⁾ The objective of the present review was to evaluate the results of studies involving different types of pulmonary rehabilitation programs in patients with COPD, as well as to classify such studies in accordance with criteria for the determination of the level of scientific evidence (grade of recommendation).

Article selection

We searched five databases: PubMed; Web of Science; EMBASE; Cumulative Index to Nursing and Allied Health Literature; and LILACS. We selected articles published between 2005 and 2009, written in English, Spanish, or Portuguese. We combined COPD descriptors with various treatment descriptors that included the term “rehabilitation”. This allowed us to find a larger number of articles. We applied inclusion and exclusion criteria in order to select articles that were in conformity with the principal objective of the present review. The articles were categorized by level of scientific evidence (grade of recommendation A, B, or C). In general, a grade A recommendation applies when the evidence is from randomized controlled clinical trials with a rich body of data. A grade B recommendation applies when the evidence is from randomized controlled clinical trials with limited body of data, whereas a grade C recommendation applies when the evidence is from observational studies or nonrandomized clinical trials. To provide a better understanding of the treatments described in the present review, we have defined them in Chart 1. In addition to the definitions shown in Chart 1, we used the term “baseline” or “baseline characteristics” to describe studies comparing parameters before and after pulmonary rehabilitation. Nonrandomized before-and-after studies were included in the present review because of the considerable number of such studies in the scientific literature on pulmonary rehabilitation. The results of the present review are presented by outcome of interest, namely pulmonary function, exacerbation, exercise capacity/tolerance, mortality, symptoms, and quality of life. For the outcomes exercise capacity/tolerance, quality of life, and symptoms, we created standardized figures. The remaining outcomes are presented exclusively as text. The figures show comparisons between standard rehabilitation (x axis) and other types of treatment (y axis). We present the number of analyses found for each comparison, as well as the levels of scientific evidence (grades of recommendation), adapted from the Global Initiative for Chronic Obstructive Lung Disease (GOLD) criteria.⁽²⁾ We also present the results obtained with pulmonary rehabilitation, i.e., whether standard rehabilitation had positive or negative effects, or whether there were no differences between standard rehabilitation

Chart 1 – Definitions of rehabilitation strategies.

Strategy	Definition
Standard rehabilitation	Program including strength and resistance exercises involving lower and upper limbs. It can also include relaxation exercises and stretching.
Partial rehabilitation	Program that is similar to standard rehabilitation but involves fewer or shorter sessions. It can also include strength and resistance exercises involving only one set of limbs.
Standard treatment	Treatment involving standard care. In general, it involved only pharmacological treatment.
Strength exercises	Program including exercises aimed at increasing muscle strength. The exercises can involve upper limbs, lower limbs, or both. In few cases, the exercises involved both sets of limbs.
Resistance exercises	Program including resistance exercises aimed at improving muscle capacity and resistance, as well as respiratory capacity and resistance. The exercises can involve upper limbs, lower limbs, or both.

and a given treatment. The figures illustrate only the treatments that were classified as standard treatment (use of medications), partial rehabilitation (standard rehabilitation in fewer sessions, shorter sessions, or both), strength exercises, resistance exercises, or baseline. Systematic reviews and meta-analysis of the theme were not included in the analyses but were used in the considerations of the findings. The methods employed in the present systematic review are described in detail in the online supplement of the Journal (http://www.jornaldepneumologia.com.br/english/artigo_detalhes.asp?id=1785).

Principal findings

Our systematic search identified 40 articles on pulmonary rehabilitation in patients with COPD. Because each article could have more than one outcome, as well as presenting a comparison of various rehabilitation programs, the articles selected generated 181 analyses (identified by cross-referencing the outcomes studied with the various rehabilitation programs tested). In accordance with the GOLD criteria for the determination of the level of scientific evidence (grade of recommendation), only 4 articles received a grade A recommendation. Of the remaining 36 articles, 18 received a grade A recommendation and 18 received a grade C recommendation. The analyses of the outcome measures of the present study are presented below.

Exercise capacity/tolerance

The analyses of exercise capacity/tolerance as an outcome measure originated mostly from articles receiving a grade B or C recommendation.

In over half of those analyses, the severity of COPD was not specified. The results of the comparison between standard rehabilitation and other rehabilitation methods/programs regarding exercise capacity/tolerance are shown in Figure 1. The test that was most commonly used in order to evaluate the exercise capacity/tolerance outcome measure was the six-minute walk test (6MWT), classified here as a measure of exercise tolerance. In comparison with the pre-rehabilitation period (baseline), standard rehabilitation was shown to be beneficial in 18 of the 20 such analyses identified; the remaining 2 analyses showed no difference between baseline and standard rehabilitation (Figure 1). Those analyses primarily examined exercise tolerance.^(6,7) Three of the 6 analyses of the comparison between standard rehabilitation and partial rehabilitation^(8,9) showed that the effects of standard rehabilitation on exercise capacity/tolerance were better than were those of partial rehabilitation (Figure 1). All of the analyses examined exercise tolerance. In 2 of the 3 analyses identified, a standard rehabilitation program was shown to improve exercise tolerance when compared with the standard (i.e., pharmacological) treatment (Figure 1).^(10,11) In the analysis in which there was no difference between the two groups in terms of their effects on exercise tolerance, the severity of COPD was not specified.⁽¹²⁾ Figure 1 shows that there were no differences in exercise-related outcomes when the analyses involving standard rehabilitation were compared with those involving strength or resistance exercises exclusively. We also found analyses involving other rehabilitation-related interventions. Deacon et al.⁽¹³⁾ demonstrated, through biopsy,

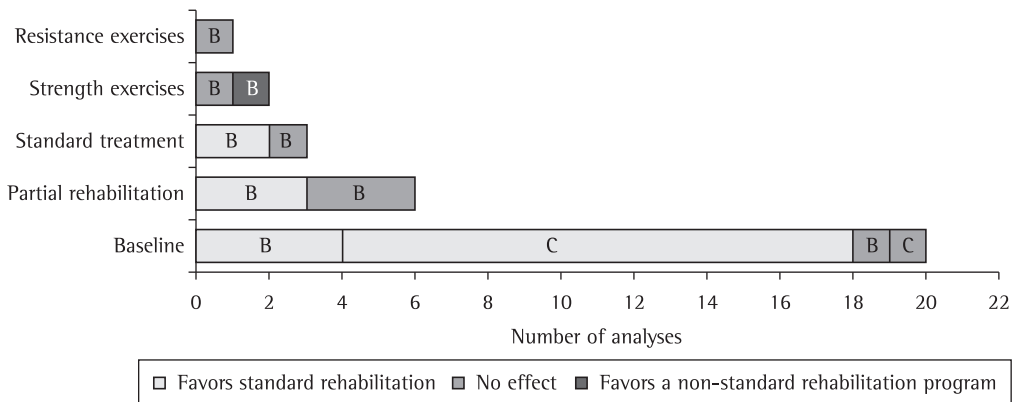


Figure 1 - Effects of standard rehabilitation, compared with those of other rehabilitation strategies, on the exercise capacity/tolerance outcome measure, by level of scientific evidence (grade of recommendation).

improvements in certain biochemical indicators (creatine, total creatine, and phosphocreatine) in patients who underwent standard rehabilitation complemented with creatine in comparison with those who underwent standard rehabilitation exclusively. However, the authors found no differences between the two groups of patients in terms of the effects of the treatment on muscle performance. The effects that standard rehabilitation combined with ventilation-feedback training,⁽¹⁴⁾ noninvasive ventilation,⁽¹⁵⁾ or tiotropium use⁽¹⁶⁾ had on exercise tolerance were shown to be no better than were those of standard rehabilitation alone. Only 1 analysis⁽¹⁷⁾ demonstrated that standard rehabilitation combined with tiotropium use was superior to standard rehabilitation alone.

Quality of life

Articles evaluating the quality of life of COPD patients submitted to various rehabilitation programs generated 61 analyses. Of those, most were based on standardized questionnaires, such as the chronic respiratory questionnaire (CRQ), the Saint George’s Respiratory Questionnaire (SGRQ), and the Medical Outcomes Study 36-item Short-Form Health Survey (SF-36). As occurred for the exercise capacity/tolerance outcome measure, most of the analyses originated from articles receiving a grade B or C recommendation. Figure 2 shows a comparison between standard rehabilitation and other treatments. Standard rehabilitation was shown to improve the pre-treatment characteristics in 19 of the 22 analyses identified. All of the articles

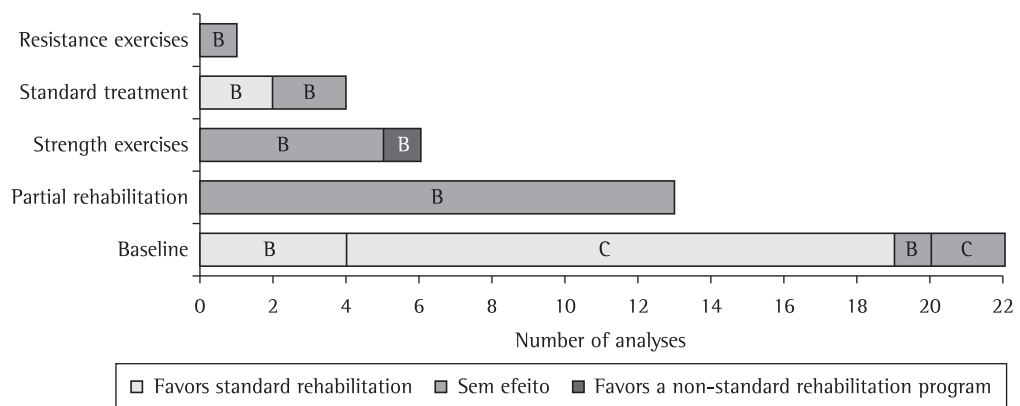


Figure 2 - Effects of standard rehabilitation, compared with those of other rehabilitation strategies, on the quality of life outcome measure, by level of scientific evidence (grade of recommendation).

in which the severity of COPD was mentioned involved patients with moderate to very severe disease.⁽¹⁸⁻²³⁾ There were no differences among standard rehabilitation, resistance exercises, strength exercises, and partial rehabilitation in terms of their impact on quality of life (Figure 2). In 3 of those studies,^(8,9,24) the severity of COPD was not specified, whereas in the other 3, patients presented with moderate to very severe COPD.^(16,25,26) In 1 analysis, the use of strength exercises was shown to improve quality of life, by reducing the difficulty in performing activities of daily living, when compared with the use of standard rehabilitation.⁽¹⁶⁾ Standard rehabilitation had a better effect on quality of life than did the standard treatment, as assessed by the SF-36 physical domain score⁽¹²⁾ and the total SGRQ score.⁽¹⁰⁾ None of those analyses specified the severity of COPD. In 3 analyses, there were no differences between pre- and post-treatment quality of life⁽²⁷⁾ when the rehabilitation program under study involved strength exercises. In contrast, post-resistance exercise quality of life was shown to be better than baseline quality of life⁽²⁸⁾ and post-standard treatment quality of life⁽²⁹⁾ (1 analysis each). The effects that combining a given rehabilitation program with creatine,⁽¹³⁾ tiotropium,^(17,30) or hypertonic saline⁽³¹⁾ had on quality of life did not differ from those observed when the rehabilitation program was used in isolation. Duiverman et al.⁽¹⁵⁾ compared the use of rehabilitation programs in isolation with the that of those same programs in combination with noninvasive ventilation and found that the latter improved quality of life in 2 of 4 analysis examining the degree of fatigue.

Symptoms

The articles reviewed generated 23 analyses of the outcome measure symptoms. Of those 23, only 4 received a grade A recommendation.^(17,30,31) The remaining analyses received a grade B or C recommendation, in equal proportions. Figure 3 shows the comparisons between standard rehabilitation and other treatments. Before-and-after studies showed that standard rehabilitation improved COPD symptoms in 6 of the 7 analyses identified. All of the analyses evaluated the degree of dyspnea. The only analysis that showed no significant differences was one evaluating the level of anxiety in patients with COPD.⁽²⁰⁾ As can be seen in Figure 3, 1 analysis compared partial rehabilitation^(26,32) and standard rehabilitation in terms of their impact on the degree of dyspnea and found no differences between the two. One analysis showed that strength exercises yielded better results than did standard rehabilitation⁽¹⁶⁾ in patients with moderate to very severe COPD. Of the analyses comparing standard rehabilitation and the standard treatment, only 1 showed that the former had positive effects⁽¹⁰⁾ on the symptoms (Figure 3). One study⁽²⁸⁾ showed that resistance exercises improved the symptoms of dyspnea in comparison with baseline data, although there were no differences between the groups in terms of patient perception of dyspnea after the 6MWT. Combining rehabilitation with the use of tiotropium,⁽¹⁷⁾ noninvasive ventilation,⁽¹⁵⁾ or hypertonic saline⁽³¹⁾ had no additional effect on symptoms when compared with the standard rehabilitation program. However, Collins et al.

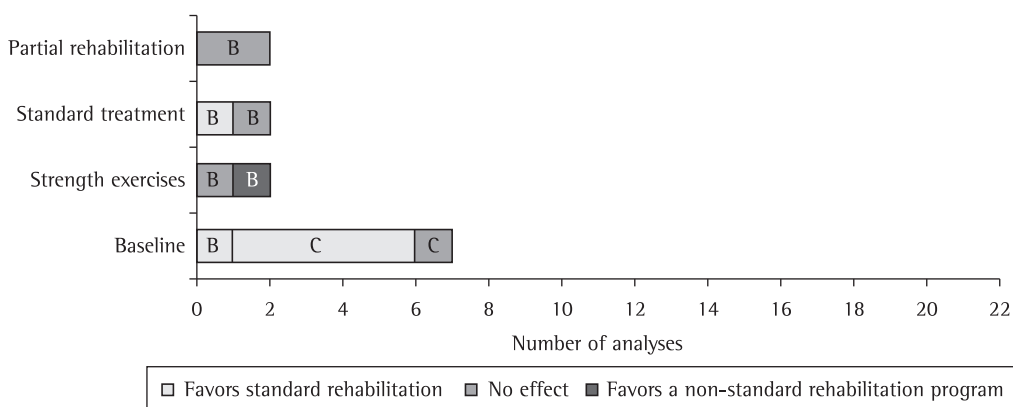


Figure 3 – Effects of standard rehabilitation, compared with those of other rehabilitation strategies, on the symptoms outcome measure, by level of scientific evidence (grade of recommendation)

⁽¹⁴⁾ noted an improvement in the RR of patients in whom ventilation-feedback training was combined with standard rehabilitation.

Pulmonary function

The articles selected generated 20 analyses involving aspects related to pulmonary function. Half of those analyses received a grade C recommendation, and only 1 received a grade A recommendation. In 8 analyses, the severity of COPD was not specified. In 12 analyses, data obtained after standard rehabilitation were compared with those obtained before rehabilitation. Of those 12, 6 showed that standard rehabilitation yielded favorable results,^(6,20,33,34) whereas 1 showed that pre-rehabilitation FEV₁ was higher than was post-rehabilitation FEV₁.⁽³⁵⁾ In contrast, Stav et al.⁽¹¹⁾ showed that the FEV₁ in patients with severe COPD who underwent standard rehabilitation improved in comparison with that observed in patients who underwent the standard treatment. There were no significant differences between patients who underwent the standard treatment and those who performed resistance exercises regarding pulmonary function,⁽²⁹⁾ although pulmonary function improved in both groups of patients. Combining rehabilitation programs with ventilation-feedback training,⁽¹⁴⁾ tiotropium use,⁽³⁰⁾ or noninvasive ventilation⁽¹⁵⁾ was ineffective in improving the pulmonary function of patients with moderate to very severe COPD in relation to that of those who exclusively underwent a rehabilitation program.

Exacerbation

The articles selected generated 23 analyses of COPD exacerbation. Of those 23 analyses, 18 received a grade C recommendation. Nearly all of the analyses involved hospitalizations, emergency room visits, or consultations with health professionals. Standard rehabilitation was the type of treatment that was most commonly evaluated (in 22 of the 23 analyses), having been compared either with baseline data or with the standard treatment. In 15 of the 18 analyses comparing baseline data with data obtained after standard rehabilitation, standard rehabilitation was shown to have positive effects on COPD exacerbations, most of the analyses having involved patients with moderate to very

severe COPD.^(18,36-38) The analyses that showed no differences between baseline data and those obtained after standard rehabilitation evaluated the length of hospital stay,⁽³⁸⁾ emergency room visits, and the number of visits by nursing teams.⁽³⁹⁾ In 4 analyses, the standard treatment was compared with standard rehabilitation. Of those, only 1 showed improvement, the hospital stay having been shorter six months after the end of the intervention.⁽¹⁰⁾ Finally, 1 analysis showed that resistance exercises combined with tiotropium use reduced the need for rescue medications when compared with the use of resistance exercises in isolation.⁽¹⁷⁾

Mortality

We found only 4 analyses in which mortality was the outcome measure. In 3 of those analyses, the Body mass index, airway Obstruction, Dyspnea, and Exercise capacity (BODE) index was used as a predictor of mortality.^(12,29,36) In 1, deaths were evaluated.⁽³⁶⁾ Of the 4 analyses, 2 received a grade B recommendation and 2 received a grade C recommendation. Standard rehabilitation was shown to be better than was the standard treatment for the outcome measure mortality,⁽³⁶⁾ whereas resistance exercises⁽²⁹⁾ and standard rehabilitation,⁽¹²⁾ when compared with the standard treatment, had no effect on mortality. In 2 of the 4 analyses, patients presented with moderate to very severe COPD,⁽³⁶⁾ whereas in the remaining 2 the severity of the disease was not specified.

Considerations

Our review presents important results regarding the effects of rehabilitation programs on outcome measures in patients with COPD. However, certain aspects of the methods employed in the articles selected should be discussed. Few of the studies investigating pulmonary rehabilitation treatments included ≥ 100 individuals. Of the 40 articles included in the present review, only 19 (less than half) involved ≥ 100 individuals, which means that the studies analyzed might not have enough power to detect statistically significant differences. Despite that limitation, the results of the analyses that originated from studies involving ≤ 100 individuals were similar to those of the analyses that originated from studies involving

≥ 100 individuals (data not shown). Unlike what occurs in studies investigating pharmacological treatments, in which participants can be blinded, it is difficult to blind participants to the treatment being provided in studies investigating treatments that require the understanding and cooperation of patients. Therefore, we cannot rule out the possibility that the results were biased and influenced our findings regarding the effects of the pulmonary rehabilitation programs. Although the participants were not blinded, they were randomized in half of the studies included in the present review. A before-and-after design is commonly used in studies of rehabilitation. Therefore, studies with that type of design were included in the present review. The lack of blinding, as well as the inclusion of before-and-after studies, led us to classify a large number of analyses as having a grade of recommendation of B or C. The severity of COPD also merits discussion. Most of the studies did not specify the severity of the disease. The severity of COPD was specified in only 3 studies: 2 involved patients with severe COPD^(11,15); and 1 investigated patients with very severe COPD.⁽¹⁹⁾ The remaining studies involved patients with moderate to severe COPD or with moderate to very severe COPD. The lack of information regarding the severity of COPD makes it difficult to identify the group of patients in whom the effects of rehabilitation are most pronounced. It is possible that the impact of pulmonary rehabilitation varies according to the severity of the disease. The following considerations are presented by outcome in order to facilitate their understanding.

Exercise capacity/tolerance

Improvement in exercise capacity or tolerance (or both) was shown to be an important indicator in the evaluation of the effectiveness of pulmonary rehabilitation programs in patients with COPD. Our results showed that approximately 28% of the analyses examined the exercise capacity/tolerance outcome measure. Well-established tests, such as the 6MWT, were the tests that were most commonly used, which made it possible to compare results across studies. Most of our findings originated from studies that assessed the baseline characteristics of patients with COPD and compared those characteristics with data obtained after the completion of a given

rehabilitation program. It is also of note that over 60% of the analyses of exercise capacity/tolerance as an outcome measure involved standard rehabilitation, and very few conclusions can be drawn from the comparison of different types of treatment. Nevertheless, systematic reviews comparing treatments were conducted and showed controversial results. Regarding standard rehabilitation, the results suggest the same improvement in relation to exercise-related aspects, principally when compared with baseline. Those findings are similar to those of Lacasse et al.⁽⁴⁰⁾ in a study evaluating maximal exercise capacity, as well as to those of O'Shea et al.⁽⁴¹⁾ in a study evaluating exercise tolerance. The meta-analysis conducted by O'Shea et al.⁽⁴¹⁾ compared standard rehabilitation with resistance exercises and found no differences between the two regarding the outcome measure exercise tolerance. Oh & Seo conducted a meta-analysis⁽⁴²⁾ and found no differences between standard and partial rehabilitation programs in terms of their impact on the exercise capacity of patients with COPD, the severity of which was not specified. Resistance exercises were compared with standard rehabilitation in only 1 analysis, which showed no differences between the two treatments in terms of their ability to improve exercise capacity. A meta-analysis conducted by Crowe et al.⁽⁴³⁾ demonstrated an improvement in the inspiratory muscle strength of patients who underwent specific training of such muscles in comparison with that of patients who underwent standard rehabilitation; however, standard rehabilitation was shown to have a better effect on exercise tolerance, a finding that is in agreement with our results. O'Brien et al. conducted a meta-analysis⁽⁴⁴⁾ in which they compared the same treatments as did Crowe et al.⁽⁴³⁾ and found no differences between the two approaches. There are few studies involving strength exercises, and such studies suggest that there are no differences between strength exercises and standard rehabilitation. Puhan et al.⁽⁴⁵⁾ conducted a meta-analysis in which they compared the effects of strength or resistance exercises with those of standard rehabilitation on the six-minute walk distance and found no differences among the types of exercise. However, a review by Houchen et al.⁽⁴⁶⁾ demonstrated that quadriceps muscle strength was greater in patients who underwent strength

exercises than in those who underwent standard rehabilitation. Neither study^(45,46) specified the severity of COPD.

Health-related quality of life

Quality of life has been consistently evaluated in various diseases; in chronic diseases, such as COPD, in which quality of life is generally affected, there have been various studies evaluating that outcome. In addition, the GOLD report emphasizes that improvement in the quality of life of patients is among the principal objectives of rehabilitation programs.⁽²⁾ Nearly all of the studies included in the present review used standardized instruments in order to assess health-related quality of life, and the SGRQ was the instrument that was most commonly used. The use of the same instrument in different studies facilitates the comparison of the findings. Regarding the comparison between standard rehabilitation and baseline in terms of quality of life, the results of the present review are similar to those of the meta-analysis conducted by Lacasse et al.,⁽⁴⁰⁾ who used the SGRQ and the CRQ in order to evaluate quality of life parameters in patients with severe to very severe COPD. Although only half of the analyses in the present review showed that standard rehabilitation was superior to the standard treatment in terms of improving the quality of life of patients, three other reviews^(45,47,48) reported the same result. We found no differences between strength or resistance exercises and standard rehabilitation in terms of their impact on quality of life, a finding that corroborates the results of one systematic review.⁽⁴⁵⁾ Although we found no analyses comparing strength and resistance exercises, the review conducted by Puhan et al.⁽⁴⁵⁾ found no differences between the two types of treatment in terms of their impact on quality of life, as assessed by the CRQ score, which was better in those who underwent strength exercises.

Symptoms

Health professionals who treat patients with COPD commonly investigate the evolution of the symptoms of the disease. Most of the 23 analyses involving COPD symptoms evaluated dyspnea. According to the 2004 Second Brazilian Consensus on COPD,⁽⁴⁹⁾ dyspnea is an

important symptom, which can cause disability, impair quality of life, and worsen the prognosis. It is of note that, in general, only patients with COPD that is more severe perceive dyspnea. The identification of the symptom can be delayed by the fact that the physical disability is attributed to aging and lack of physical conditioning. The instruments that were most commonly used in order to evaluate dyspnea were the CRQ and the Borg scale. As in the present review, systematic reviews comparing patients who underwent standard rehabilitation with those who received the standard treatment revealed that COPD symptoms improved in the former.^(45,47,48) An improvement in dyspnea was also found when the symptoms observed before pulmonary rehabilitation were compared with those observed after pulmonary rehabilitation.⁽⁴⁰⁾ Our study showed that strength exercises and standard rehabilitation have similar beneficial effects on COPD symptoms, a finding that corroborates results reported in the literature.⁽⁴⁵⁾ Although we found no studies comparing inspiratory muscle training and placebo, the review by O'Brien et al.⁽⁴⁴⁾ reported that inspiratory muscle training had a beneficial effect on COPD symptoms when compared with a type of exercise that was classified as placebo. This underscores the importance of pulmonary rehabilitation programs for the improvement of COPD symptoms, especially dyspnea.

Pulmonary function

The principal pulmonary function measurements found in the present review were FEV₁ and FVC. The progressive decline in pulmonary function found in patients with COPD is considered a major prognostic factor of the course of the disease.⁽⁴⁹⁾ It is plausible to think that by managing and controlling those parameters we can change the natural evolution of COPD. Professionals working in the field of pulmonary rehabilitation should bear that in mind. Our finding that pre-rehabilitation FEV₁ values were higher than were post-rehabilitation FEV₁ values can be explained by the natural progression of the disease, which is accompanied by a decline in that pulmonary function measurement. The findings of the present study regarding pulmonary function parameters in COPD patients before and after standard rehabilitation were similar to those

of other studies.⁽⁴⁰⁾ Lacasse et al.⁽⁴⁷⁾ compared standard rehabilitation with the standard (i.e., pharmacological) treatment in terms of their impact on pulmonary function and also found that the former was more beneficial. However, pulmonary rehabilitation is not expected to have a direct impact on pulmonary function variables. One factor that might have contributed to the improvement in pulmonary function brought about by the intervention and that was not evaluated in any of the studies is improved pharmacological treatment compliance induced by a more meticulous patient follow-up during the rehabilitation program.

Exacerbation

Although most of the analyses in the present review compared standard rehabilitation in before-and-after studies, the results obtained were similar to those reported in the few review articles and meta-analyses found in the literature. Those reviews suggest that standard rehabilitation reduces the number of hospitalizations^(45,48) but not the length of hospital stays.⁽⁵⁰⁾ The length of hospital stay, the number of emergency room visits, and the number of consultations with health professionals were the exacerbation indicators used in the studies included in the present review. Such aspects have an impact on private and public health system costs. In addition, COPD exacerbations have a negative impact on the ability of individuals to work. Therefore, pulmonary rehabilitation programs in patients with COPD can become an essential tool for the prognosis of the disease.

Mortality

In the present review, 4 analyses evaluated the outcome measure mortality. Of those, 3 employed the BODE index, which is considered a predictor of mortality. However, the reviews found in the literature indicate that standard rehabilitation reduces mortality, principally post-exacerbation mortality,⁽⁴⁸⁾ when compared with the standard (pharmacological) treatment.^(45,48) Few studies have evaluated the potential benefits of rehabilitation programs in terms of mortality. Such studies usually involve small samples, and certain aspects of the methods employed are somewhat inappropriate. However,

a meta-analysis conducted by Puhan et al.⁽⁴⁸⁾ showed that pulmonary rehabilitation is a safe and effective intervention for reducing COPD-related mortality. Another interesting finding reported in the literature but not confirmed by the present review is that oxygen therapy seems to reduce mortality.⁽⁵¹⁾ For many years, oxygen therapy was considered to be one of the few treatments, apart from smoking cessation, capable of reducing mortality. Oxygen therapy in combination with a good pharmacological treatment and an excellent rehabilitation program can be beneficial in terms of reducing mortality in patients with COPD. However, the effects of that combination of measures on COPD-related mortality should be investigated further.

Final considerations

Pulmonary rehabilitation programs can be considered to constitute important tools in the therapeutic armamentarium available for patients with COPD. The beneficial effects of this type of intervention on exercise capacity, quality of life, and symptoms, when compared with those of the standard pharmacological treatment or with pre-rehabilitation parameters, are well known. In addition, pulmonary rehabilitation seems to have some effects on pulmonary function, exacerbations, and mortality. However, such outcomes should be investigated further. In addition, when programs involving different types of exercise are compared, no exercise modality appears to be superior to the others. Furthermore, because most of the studies included in the present review did not specify the severity of COPD or evaluated a heterogeneous group of patients with regard to the functional classification, it is impossible to determine which groups of patients might benefit the most or the least from pulmonary rehabilitation. However, despite that limitation, the beneficial effects of pulmonary rehabilitation on the outcomes studied are evident. In conclusion, the present review can serve to make health administrators aware of the benefits of pulmonary rehabilitation in patients with COPD, promoting the development of public policies related to such treatment.

References

- Ries AL, Bauldoff GS, Carlin BW, Casaburi R, Emery CF, Mahler DA, et al. Pulmonary Rehabilitation: Joint ACCP/AACVPR Evidence-Based Clinical Practice Guidelines. *Chest*. 2007;131(5 Suppl):4S-42S.
- Global Initiative for Chronic Obstructive Lung Disease. *Estratégia Global para Diagnóstico, Condução e Prevenção da Doença Pulmonar Obstrutiva Crônica*. Bethesda: National Institutes of Health, National Heart, Lung, and Blood Institute; 2006.
- Sívori M, Almeida M, Benzo R, Boim C, Brassesco M, Callejas O, et al. New Argentine consensus of respiratory rehabilitation 2008 [Article in Spanish]. *Medicina (B Aires)*. 2008;68(4):325-44.
- Langer D, Hendriks E, Burtin C, Probst V, van der Schans C, Paterson W, et al. A clinical practice guideline for physiotherapists treating patients with chronic obstructive pulmonary disease based on a systematic review of available evidence. *Clin Rehabil*. 2009;23(5):445-62.
- Ries AL. Pulmonary rehabilitation: summary of an evidence-based guideline. *Respir Care*. 2008;53(9):1203-7.
- Cortopassi F, Castro AA, Porto EF, Colucci M, Fonseca G, Torre-Bouscoulet L, et al. Comprehensive exercise training improves ventilatory muscle function and reduces dyspnea perception in patients with COPD. *Monaldi Arch Chest Dis*. 2009;71(3):106-12.
- Skumlien S, Skogedal EA, Bjørtuft O, Ryg MS. Four weeks' intensive rehabilitation generates significant health effects in COPD patients. *Chron Respir Dis*. 2007;4(1):5-13.
- Sewell L, Singh SJ, Williams JE, Collier R, Morgan MD. How long should outpatient pulmonary rehabilitation be? A randomised controlled trial of 4 weeks versus 7 weeks. *Thorax*. 2006;61(9):767-71.
- Varga J, Porszasz J, Boda K, Casaburi R, Somfay A. Supervised high intensity continuous and interval training vs. self-paced training in COPD. *Respir Med*. 2007;101(11):2297-304.
- Boxall AM, Barclay L, Sayers A, Caplan GA. Managing chronic obstructive pulmonary disease in the community. A randomized controlled trial of home-based pulmonary rehabilitation for elderly housebound patients. *J Cardiopulm Rehabil*. 2005;25(6):378-85.
- Stav D, Raz M, Shpirer I. Three years of pulmonary rehabilitation: inhibit the decline in airflow obstruction, improves exercise endurance time, and body-mass index, in chronic obstructive pulmonary disease. *BMC Pulm Med*. 2009;9:26.
- Eaton T, Young P, Fergusson W, Moodie L, Zeng I, O'Kane F, et al. Does early pulmonary rehabilitation reduce acute health-care utilization in COPD patients admitted with an exacerbation? A randomized controlled study. *Respirology*. 2009;14(2):230-8.
- Deacon SJ, Vincent EE, Greenhaff PL, Fox J, Steiner MC, Singh SJ, et al. Randomized controlled trial of dietary creatine as an adjunct therapy to physical training in chronic obstructive pulmonary disease. *Am J Respir Crit Care Med*. 2008;178(3):233-9.
- Collins EG, Langbein WE, Fehr L, O'Connell S, Jelinek C, Hagarty E, et al. Can ventilation-feedback training augment exercise tolerance in patients with chronic obstructive pulmonary disease? *Am J Respir Crit Care Med*. 2008;177(8):844-52.
- Duiverman ML, Wempe JB, Bladder G, Jansen DF, Kerstjens HA, Zijlstra JG, et al. Nocturnal non-invasive ventilation in addition to rehabilitation in hypercapnic patients with COPD. *Thorax*. 2008;63(12):1052-7.
- Costi S, Crisafulli E, Antoni FD, Beneventi C, Fabbri LM, Clini EM. Effects of unsupported upper extremity exercise training in patients with COPD: a randomized clinical trial. *Chest*. 2009;136(2):387-95.
- Casaburi R, Kukafka D, Cooper CB, Witek TJ Jr, Kesten S. Improvement in exercise tolerance with the combination of tiotropium and pulmonary rehabilitation in patients with COPD. *Chest*. 2005;127(3):809-17.
- Cecins N, Geelhoed E, Jenkins SC. Reduction in hospitalisation following pulmonary rehabilitation in patients with COPD. *Aust Health Rev*. 2008;32(3):415-22.
- Fernández AM, Pascual J, Ferrando C, Arnal A, Vergara I, Sevilla V. Home-based pulmonary rehabilitation in very severe COPD: is it safe and useful? *J Cardiopulm Rehabil Prev*. 2009;29(5):325-31.
- Haave E, Hyland ME, Engvik H. Improvements in exercise capacity during a 4-weeks pulmonary rehabilitation program for COPD patients do not correspond with improvements in self-reported health status or quality of life. *Int J Chron Obstruct Pulmon Dis*. 2007;2(3):355-9.
- Karapolat H, Atasever A, Atamaz F, Kirazli Y, Elmas F, Erdinç E. Do the benefits gained using a short-term pulmonary rehabilitation program remain in COPD patients after participation? *Lung*. 2007;185(4):221-5.
- Lavolette L, Bourbeau J, Bernard S, Lacasse Y, Pepin V, Breton MJ, et al. Assessing the impact of pulmonary rehabilitation on functional status in COPD. *Thorax*. 2008;63(2):115-21.
- Takigawa N, Tada A, Soda R, Takahashi S, Kawata N, Shibayama T, et al. Comprehensive pulmonary rehabilitation according to severity of COPD. *Respir Med*. 2007;101(2):326-32.
- Sewell L, Singh SJ, Williams JE, Collier R, Morgan MD. Can individualized rehabilitation improve functional independence in elderly patients with COPD? *Chest*. 2005;128(3):1194-200.
- Arnardóttir RH, Sörensen S, Ringqvist I, Larsson K. Two different training programmes for patients with COPD: a randomised study with 1-year follow-up. *Respir Med*. 2006;100(1):130-9.
- Maltais F, Bourbeau J, Shapiro S, Lacasse Y, Perrault H, Baltzan M, et al. Effects of home-based pulmonary rehabilitation in patients with chronic obstructive pulmonary disease: a randomized trial. *Ann Intern Med*. 2008;149(12):869-78.
- O'Shea SD, Taylor NF, Paratz JD. A predominantly home-based progressive resistance exercise program increases knee extensor strength in the short-term in people with chronic obstructive pulmonary disease: a randomised controlled trial. *Aust J Physiother*. 2007;53(4):229-37.
- Heppner PS, Morgan C, Kaplan RM, Ries AL. Regular walking and long-term maintenance of outcomes after pulmonary rehabilitation. *J Cardiopulm Rehabil*. 2006;26(1):44-53.
- Barakat S, Michele G, George P, Nicole V, Guy A. Outpatient pulmonary rehabilitation in patients with chronic obstructive pulmonary disease. *Int J Chron Obstruct Pulmon Dis*. 2008;3(1):155-62.

30. Lindsay M, Lee A, Chan K, Poon P, Han LK, Wong WC, Wong S. Does pulmonary rehabilitation give additional benefit over tiotropium therapy in primary care management of chronic obstructive pulmonary disease? Randomized controlled clinical trial in Hong Kong Chinese. *J Clin Pharm Ther.* 2005;30(6):567-73.
31. Valderamas SR, Atallah AN. Effectiveness and safety of hypertonic saline inhalation combined with exercise training in patients with chronic obstructive pulmonary disease: a randomized trial. *Respir Care.* 2009;54(3):327-33.
32. Arnardóttir RH, Boman G, Larsson K, Hedenström H, Emtner M. Interval training compared with continuous training in patients with COPD. *Respir Med.* 2007;101(6):1196-204.
33. Carone M, Patessio A, Ambrosino N, Baiardi P, Balbi B, Balzano G, et al. Efficacy of pulmonary rehabilitation in chronic respiratory failure (CRF) due to chronic obstructive pulmonary disease (COPD): The Maugeri Study. *Respir Med.* 2007;101(12):2447-53.
34. Riario-Sforza GG, Incorvaia C, Paterniti F, Dugnani N, Fumagalli M. Different outcomes of pulmonary rehabilitation in patients with COPD with or without exacerbations. *Monaldi Arch Chest Dis.* 2005;63(3):129-32.
35. López Varela MV, Anido T, Larrosa M. Functional status and survival in patients with chronic obstructive pulmonary disease following pulmonary rehabilitation [Article in Spanish]. *Arch Bronconeumol.* 2006;42(9):434-9.
36. Cote CG, Celli BR. Pulmonary rehabilitation and the BODE index in COPD. *Eur Respir J.* 2005;26(4):630-6.
37. Rasekaba TM, Williams E, Hsu-Hage B. Can a chronic disease management pulmonary rehabilitation program for COPD reduce acute rural hospital utilization? *Chron Respir Dis.* 2009;6(3):157-63.
38. Ringbaek T, Brøndum E, Martínez G, Lange P; Pulmonary Rehabilitation Research Group. Rehabilitation in COPD: the long-term effect of a supervised 7-week program succeeded by a self-monitored walking program. *Chron Respir Dis.* 2008;5(2):75-80.
39. Raskin J, Spiegler P, McCusker C, ZuWallack R, Bernstein M, Busby J, et al. The effect of pulmonary rehabilitation on healthcare utilization in chronic obstructive pulmonary disease: The Northeast Pulmonary Rehabilitation Consortium. *J Cardiopulm Rehabil.* 2006;26(4):231-6.
40. Lacasse Y, Martin S, Lasserson TJ, Goldstein RS. Meta-analysis of respiratory rehabilitation in chronic obstructive pulmonary disease. A Cochrane systematic review. *Eura Medicophys.* 2007;43(4):475-85.
41. O'Shea SD, Taylor NF, Paratz JD. Progressive resistance exercise improves muscle strength and may improve elements of performance of daily activities for people with COPD: a systematic review. *Chest.* 2009;136(5):1269-83.
42. Oh H, Seo W. Meta-analysis of the effects of respiratory rehabilitation programmes on exercise capacity in accordance with programme characteristics. *J Clin Nurs.* 2007;16(1):3-15.
43. Crowe J, Reid WD, Geddes EL, O'Brien K, Brooks D. Inspiratory muscle training compared with other rehabilitation interventions in adults with chronic obstructive pulmonary disease: a systematic literature review and meta-analysis. *COPD.* 2005;2(3):319-29.
44. O'Brien K, Geddes EL, Reid WD, Brooks D, Crowe J. Inspiratory muscle training compared with other rehabilitation interventions in chronic obstructive pulmonary disease: a systematic review update. *J Cardiopulm Rehabil Prev.* 2008;28(2):128-41.
45. Puhan MA, Scharplatz M, Troosters T, Steurer J. Respiratory rehabilitation after acute exacerbation of COPD may reduce risk for readmission and mortality -- a systematic review. *Respir Res.* 2005;6:54.
46. Houchen L, Steiner MC, Singh SJ. How sustainable is strength training in chronic obstructive pulmonary disease? *Physiotherapy.* 2009;95(1):1-7.
47. Lacasse Y, Goldstein R, Lasserson TJ, Martin S. Pulmonary rehabilitation for chronic obstructive pulmonary disease. *Cochrane Database Syst Rev.* 2006;(4):CD003793.
48. Puhan M, Scharplatz M, Troosters T, Walters EH, Steurer J. Pulmonary rehabilitation following exacerbations of chronic obstructive pulmonary disease. *Cochrane Database Syst Rev.* 2009;(1):CD005305.
49. Sociedade Brasileira de Pneumologia e Tisiologia. II Consenso Brasileiro sobre Doença Pulmonar Obstrutiva Crônica - DPOC - 2004. *J Bras Pneumol.* 2004;30(Suppl 5):S1-S42.
50. Hill K, Patman S, Brooks D. Effect of airway clearance techniques in patients experiencing an acute exacerbation of chronic obstructive pulmonary disease: a systematic review. *Chron Respir Dis.* 2010;7(1):9-17.
51. Cranston JM, Crockett AJ, Moss JR, Alpers JH. Domiciliary oxygen for chronic obstructive pulmonary disease. *Cochrane Database Syst Rev.* 2005;(4):CD001744.

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