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KNGF-Guideline

for physical therapy in patients with chronic obstructive pulmonary disease

Chronic obstructive pulmonary disease

Practice guidelines

KNGF
Royal Dutch Society for Physical Therapy

In the context of international collaboration in guideline development, the Royal Dutch Society for Physical Therapy (Koninklijk Nederlands Genootschap voor Fysiotherapie, KNGF) has decided to translate its Clinical Practice Guidelines into English, to make the guidelines accessible to an international audience. International accessibility of clinical practice guidelines in physical therapy makes it possible for therapists to use such guidelines as a reference when treating their patients. In addition, it stimulates international collaboration in the process of developing and updating guidelines. At a national level, countries could endorse guidelines and adjust them to their local situation if necessary.

The KNGF represents 20,000 members. The Society's most important activities are: promoting members' interests, improving the quality of the practice of physical therapy and strengthening the position of physical therapists in the Netherlands. In order to further the quality of physical therapy practice, KNGF has invested in Quality Assurance programs, one of which has led to the development of Clinical Practice Guidelines.

Contents

A	Introduction		1
	A.1	Objective and target group	1
	A.1.1	Objective	1
	A.1.2	Target group	1
	A.2	COPD	2
	A.3	Epidemiology	2
	A.4	Prognosis	2
B	Referral and direct access		2
C	Diagnosis		4
	C.1	History-taking	5
	C.2	Physical examination	5
	C.3	Assessment instruments	5
	C.4	Analysis	5
	C.5	Treatment plan	7
D	Treatment recommendations		7
	D.1	Physical training in the context of respiratory rehabilitation	7
	D.1.1	Types of exercise training	7
	D.1.2	Intensity of exercise training	9
	D.1.3	Frequency of exercise training	10
	D.2	Treatment modalities to improve mucus clearance	10
	D.3	Patient education and self-management	11
	D.4	Evaluation	12
	D.5	Completion of treatment and aftercare	13
E	Qualification – Equipment – Collaboration		13
F	Legal status of the guidelines		13

Supplements 14

Supplement 1	Conclusions and Recommendations	15
Supplement 2	Details of history-taking	23
Supplement 3	Physical Activity Questionnaire	24
Supplement 4	Example Dialogue for Inactive Patients	25
Supplement 5	Details of the physical examination in patients with dyspnea and impaired exercise capacity	26
Supplement 6	Details of the physical examination in patients with impaired mucus clearance	27
Supplement 7	Global Perceived Effect	28
Supplement 8	Clinical COPD Questionnaire	29
Supplement 9	Chronic Respiratory Questionnaire (CRQ)	31
Supplement 10	General approach for identification of causes of exercise limitation	57
Supplement 11	Subjects for patient education	58
Supplement 12	Requirements for physical therapist and equipment	59
Supplement 13	Glossary	60

Clinical Practice Guideline for Physical therapy in patients with COPD – Practice Guidelines

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A Introduction

The Royal Dutch Society for Physical Therapy (KNGF) *Guideline for Physical therapy in patients with COPD* provides a guide for physical therapists in the treatment of patients with COPD. This guideline is an update of the guideline published in 1998. The main reasons for the revision are the advances made over the last decade in individual tailoring of training programs, including general exercise training (interval or endurance training), resistance muscle training, respiratory muscle training, breathing exercises, non-invasive ventilation, and electrical muscle stimulation. In addition, much more emphasis is now placed on the assessment and treatment of physical inactivity in daily life. Physical *in*activity in daily life is not only a prominent feature in advanced disease stages, especially after acute exacerbations of the disease, but has also been identified early in the disease process. Furthermore, it has become clear that changing a patient's lifestyle (inactivity in daily life, smoking) requires behavioral change strategies in the early stages of the disease, to improve long term outcome in terms of of health status. The interdisciplinary integrated care team has an important role in this process. The guideline underlines the specific expertise of physical therapists, but also invites greater interaction with other health care workers both in primary and secondary health care facilities. Multidisciplinary treatment of patients with COPD is advocated in recent national and international guidelines. There is an urgent need for further development of the organization of health care networks especially in primary care for COPD patients.

The guideline consists of three parts: the practice guideline, a schematic layout (flow chart) of the main points of the guideline (summary) and a *Review of the evidence* section. All parts of the KNGF guideline can be read individually.

A.1 Objective and target group

A.1.1 Objective

The objective of the guideline is to describe evidence-based physical therapy – with regard to effectiveness, efficiency and tailored care – for COPD patients with impairments in mucus clearance, pulmonary function, peripheral and respiratory muscle function, exercise capacity, and quality of life, and with physical activity limitations in daily life due to dyspnea or exercise intolerance. The recommendations in the practice guideline are based upon the available evidence from the scientific literature (up to 21 December 2007), as well as professional and social insights, and are described in more detail in the *Review of the evidence*.

A.1.2 Target group

Specific and demonstrable knowledge and skills are required for adequate treatment of patients with COPD. The knowledge and skills can be obtained by having extensive experience working with these patients and through continuous education, including topics such as pathophysiology of COPD, respiratory mechanics, respiratory muscle function, gas exchange, exercise limitation, peripheral muscle dysfunction, symptoms and signs, medical treatment, assessment tools (exercise testing, peripheral and respiratory muscle testing, quality of life, interpretation of incremental exercise tests and pulmonary function data), peripheral and respiratory muscle training, breathing exercises, ex-

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ercise training, and patient education. Since lack of compliance with treatment is a well-known feature in the prescription of techniques for airway clearance and physical inactivity, physical therapists should also develop skills in patient education and counseling (on physical activity). Special attention should be given to the consequences of acute exacerbations of the disease. The short-term and long-term clinical consequences, such as hypersecretion, physical inactivity and deconditioning, should be anticipated in the physical therapist's treatment. Finally, treatment of COPD needs a multidisciplinary approach. Recently, agreements have been concluded between primary care workers to ensure optimal care. Physical therapists should take responsibility in terms of participation and development of multidisciplinary treatment of COPD patients.

A.2 COPD

The World Health Organization's Global Initiative for Chronic Obstructive Lung Disease (GOLD) consensus document uses the following definition: *Chronic obstructive pulmonary disease is a preventable and treatable disease with some significant extrapulmonary effects that may contribute to the severity in individual patients. Its pulmonary component is characterized by airflow limitation that is not fully reversible. The airflow limitation is usually both progressive and associated with abnormal inflammatory response of the lungs to noxious particles or gases.* In addition to dyspnea, coughing, wheezing, sputum production, and recurrent respiratory infection, systemic consequences such as deconditioning, muscle weakness, weight loss and malnutrition are often observed. Physical activity in daily life is significantly reduced compared to age-matched healthy subjects. Emotional problems such as depression, anxiety and social isolation have also been observed. These factors all contribute to the health status of the patients and include important treatable targets for physical therapy. The guideline aims to provide answers to clinical questions in two major domains of symptoms in COPD related to physical therapy:

(1) dyspnea, reduced exercise performance and physical inactivity in daily life, and
(2) impaired airway secretions clearance (Figure 1).

A.3 Epidemiology

Prevalence of COPD gradually increases with age. Seven per 1000 persons from aged 40 to 45 years (0.7%) suffered from the disease in 2003, while the prevalence among persons aged 80 to 85 years was 150 per 1000 (15%). As a result of the aging population, the prevalence of COPD will presumably continue to rise over the next decades. COPD is more prevalent in members of lower socio-economic classes. The prevalence of COPD diagnosis has decreased slightly among men in the last three decades, while a large increase was observed in women in the same period. This is probably related to an increased prevalence of smokers among women during the last 30 years. Smoking remains the single most important risk factor for the development of the disease, and about 10% to 15% of smokers are diagnosed with COPD. It is assumed that COPD remains largely underdiagnosed.

A.4 Prognosis

The predictors of mortality in COPD are age, FEV_1, smoking, hypoxemia, chronic mucus hypersecretion, breathlessness, reduced exercise capacity and daily physical activity, reduced muscle mass and muscle strength, a low body mass index and excessive weight loss. A greater annual decline in FEV_1 is observed in smokers and patients with chronic mucus hypersecretion and low physical activity level. Patients with hypoxemia at rest benefit from long-term supplemental oxygen. The use of supplemental oxygen in patients who only desaturate with exercise is controversial. Patients with more pronounced muscle weakness and somewhat less impaired ventilatory reserve might be better candidates for exercise training programs. Older age, severe lung function impairment, the presence of hypercapnia, psychosocial condition and current smoking are poor predictors of the outcome of pulmonary rehabilitation. In addition, comorbid conditions that are often present in patients with COPD, such as cardiovascular disease, diabetes, osteoporosis, and peripheral vascular disease, also benefit from exercise training. Patients with these comorbid conditions and/or advanced disease should therefore *not* be excluded from training programs. After careful examination and exercise testing, these patients should be included in training programs adapted to their needs and possibilities.

B Referral and direct access

The provision of physical therapy is related to dyspnea and reduced exercise performance and physical activity and/or impaired mucus transport. Optimal medical treatment and the patient's reasons for seeking medical care should be ascertained before starting physical therapy. Patients with COPD and those with dyspnea (including non-diagnosed patients with COPD) are generally referred by a pulmonary physician or general practitioner. Therapists providing 'direct-access physical therapy' should assess the patient's GOLD stage and MRC score. Patients in GOLD stages I and II, without functional limitations (MRC < 2) and with optimized medical management, are eligible for diagnostics and possible treatment. Even if the conclusion is 'no sense of alarm', it is recommended that the therapist should contact the patient's family doctor or a specialist (if the patient agrees, of course) in order to coordinate the further care process. In other situations, that is, if the patient has GOLD stage II and functional limitations (MRC ≥ 2) or GOLD stage III or IV, or if the GOLD stage is unknown, or the conclusion from screening is 'sense of alarm', the therapist should contact the patient's family doctor or a specialist. For further information on 'direct-access physical therapy', please consult the 2007 KNGF-richtlijn Fysiotherapeutische verslaglegging*.

The flow chart (Figure 2) shows the potential pathways for treatment of reduced exercise performance in two different modalities: a multidisciplinary rehabilitation program and a physical activity program supervised by a physical therapist in primary care. Patients with mild to moderate disease (GOLD stages I and II) and mild impairment of exercise capacity (Medical Research Council dyspnea score, MRC < 2, see Table 1) can be involved in regular physical (sports) activities. Patients with more advanced disease (GOLD III and IV) should be seen by a pulmonary physician for further multidisciplinary assessment and treatment.

** This KNGF-richtlijn Fysiotherapeutische verslaglegging (translation: KNGF-Guidelines on Reporting in Physical Therapy) is only available in Dutch.*

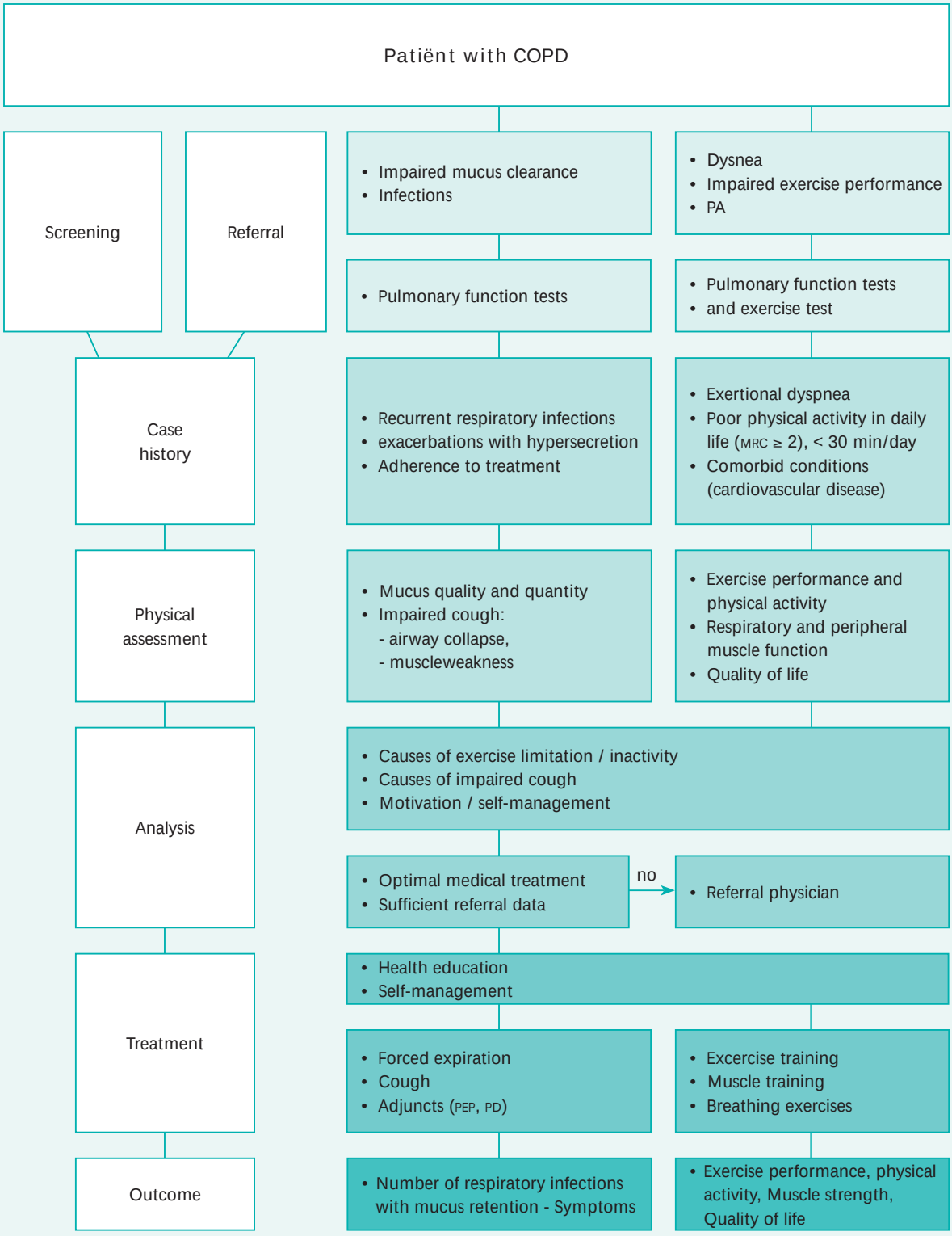

Figure 1. Flow chart for physical therapy interventions.
PA = physical activity; PEP = positive expiratory pressure; PD = postural drainage.

Table 1. Medical Research Council dyspnea scale.

Level	Description
1	I never feel short of breath.
2	I get short of breath when I have to walk up a slope.
3	I cannot keep up with other people my age when we're walking on level ground.
4	I get short of breath after walking 100 meters.
5	I feel too short of breath to leave my house.

Patients with mild disease but with more impaired functional performance (MRC ≥ 2) or increased risk for cardiovascular diseases (age, smoking, low physical activity) should have formal exercise evaluation to further assess their impaired exercise capacity as well as their ability to safely perform exercise training. The flow chart also illustrates the continuity of the (integrated care for patients with COPD. After multidisciplinary rehabilitation, exercise training should be continued in physical activity programs. Alternatively, patients participating in physical activity programs might need further multidisciplinary treatment when disease progresses or after severe acute exacerbations.

C Diagnosis

Assessment by the physical therapist includes history-taking and clinical examination to determine goals for physical therapy. In addition, objective assessment of exercise performance, respiratory and peripheral muscle function, physical activity and quality of life are integral parts of physical therapy. An understanding of the severity of the condition, including comorbidity, and its prognosis is important for drawing up an appropriate treatment plan. Therefore, relevant medical information (pulmonary function, oxygen saturation, exercise performance, drug treatment) should be included in the letter of referral (Table 2). Psychosocial data should be collected to assist in the analysis of the patient's health problems, interpret the examination results, and formulate treatment goals for physical therapy. Special attention should be given to patients with a recent his-

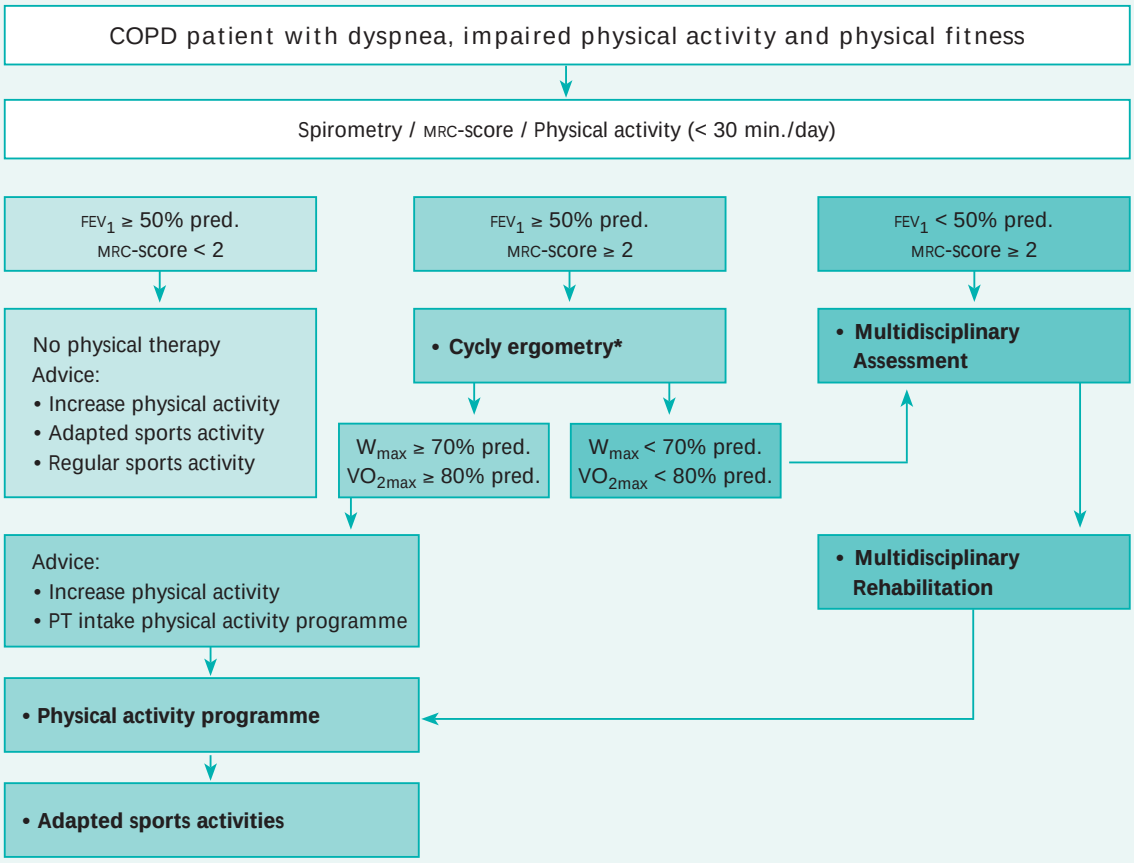

Figure 2. Diagram to guide patients to appropriate treatment modalities for symptoms related to dyspnea, exercise performance and daily physical activity.
** The 'Primary care physicians guideline' and 'Transmural guideline for COPD' only recommend exercise testing in patients with increased cardiovascular risk. The 'ACSM guideline' recommends exercise testing in any elderly subject, while the 'Physical therapy in COPD guideline' recommends exercise testing in any COPD patient.*
MRC = Medical Research Council dyspnea score
FEV = positive expiratory pressure

Table 2. Minimally required information that should be included in a letter of referral to a physical therapist.

- Medical diagnosis
- Medication
- Comorbidities (specifically related to exercise)
- Report on laboratory tests: pulmonary function test, exercise test with ECG and oxygen saturation data

tory of acute exacerbations. These patients are at risk for further deterioration of their exercise performance, quality of life, and physical activity in daily life, and need support, mostly in multidisciplinary programs to prevent them entering a downward spiral of further deterioration.

C.1 History-taking

Details of the information sought and the questions asked during history-taking include the patient's symptoms and current condition and their course over time, signs of reduced exercise capacity/physical activity, signs of impaired mucus clearance, other symptoms, coping strategies, and factors that may influence symptom development (Supplement 2 and Table 3). An example of a simple questionnaire to screen patients for inactivity is provided in Supplement 3. In addition, patients' personal goals and expectations should be formulated, and their willingness, motivation, confidence in the ability to succeed or barriers against engaging in behavioral change should be determined. (See also Supplement 4.)

C.2 Physical examination

Physical examination focuses on exercise performance, muscle strength, dyspnea and mucus retention/clearance (see also Supplement 5). Physical examination of patients with dyspnea, reduced physical activity and impaired exercise capacity involves clinical inspection (movement speed, effort, dyspnea, use of rollator, leaning forward position, cyanosis, muscle atrophy, peripheral edema), chest wall configuration (hyperinflation, deformities), respiratory movement (respiratory rate, paradoxical thoracic-abdominal movement at rest and during exercise, accessory respiratory muscle activity, activity of abdominal muscles). Additional tests to assess exercise performance, physical activity, and muscle strength are described in section C.3 of the *Review of the evidence**.

* *The Review of the evidence is only available in Dutch.*

Physical examination of patients with impaired mucus clearance focuses on the evaluation of coughing and huffing techniques and the quality and quantity of mucus (see also Supplement 6). Parameters to evaluate the quality of the patient's coughing include appropriate inspiratory volume, expiratory (abdominal) muscle contraction, and the occurrence of airway collapse or (thoracic) pain during coughing. The presence of mucus retention is assessed by listening to breathing sounds (auscultation) and palpating the chest. In addition, the quantity, color and quality of expectorated mucus are examined. Additional assessments (expiratory mouth pressure and spirometry, i.e. FEV_1, peak expiratory flow rate, flow-volume curve) are described in section C.3 of the *Review of the evidence*.

C.3 Assessment instruments

Assessment instruments may serve several purposes, such as diagnostics, prognosis and evaluation of the effectiveness of treatment. Based on the WHO ICF classification, table 4 summarizes the suggested assessment instruments to objectify clinical problems in patients with COPD.

C.4 Analysis

The analysis includes the identification of COPD-related health problems, confirming or rejecting the indication for physical therapy, goal setting for treatment, identifying factors that will enhance or impair treatment and deciding whether to apply the treatment guidelines for the individual treatment. The medical referral data and the results of history-taking and physical examination should provide a clear indication for physical therapy. On the assumption that the referring physician has correctly diagnosed COPD, and medical treatment has been optimized, the following questions should be answered:

- Are any COPD-related health problems present?
- Which body functions and activities are impaired and which problems of participation does the patient experience?
- What are the main goals of treatment?
- Which complaints, body functions and activities can be influenced by physical therapy?
- Which factors might impair or enhance treatment (motivation, confidence to change, comorbid and psychosocial conditions, etc.)?

The data obtained should enable the physical therapist to evaluate whether the referral for physical therapy is justified. If there is any doubt about the severity or nature of the disorder or about any related health problems, the referring physician or

Table 3. Main items in history-taking.

- Record the patient's health problems.
- Determine sensations of dyspnea at rest or during exercise.
- Determine signs of impaired exercise capacity; determine limitations in normal daily physical activities.
- Determine signs of impaired mucus clearance.
- Note the natural course of the symptoms and the disorder.
- Determine factors that are influencing symptoms and their progression.
- Determine the patient's need for information.
- Determine goals for treatment.

Table 4. Assessment instruments to objectify clinical problems in patients with COPD.

Clinical problem per ICF category	**Suggested assessment**
Body structure and function	
Impaired exercise tolerance	• Diagnostic maximal exercise test (medical information) • Functional exercise test (6-minute walking test*, shuttle walk test*)
Impaired skeletal muscle strength	• Isometric muscle strength (handheld) dynamometry* • Mouth pressure*
Recurrent respiratory infections with mucus retention	• History taking • Cough assessment • Pulmonary function test (medical information)
Activities and participation	
Reduced physical activity	• Medical Research Council Dyspnea • Questionnaires (e.g. brief physical activity assessment, see Supplement 3) • Activity monitoring (accelerometry)*
Symptoms of fatigue and dyspnea on exertion	• Medical Research Council Dyspnea Scale • History taking
Impaired quality of life	• History taking • Questionnaires : – Clinical COPD Questionnaire (CCQ, Supplement 7) – Chronic Respiratory Disease Questionnaire (CRQ, (Supplement 8)* – St George's respiratory questionnaire (SGRQ)* – Quality of Life for Respiratory Illness Questionnaire (QoLRIQ)
Global Perceived Effect	• Interview (Supplement 6)

** Appropriate for objective follow-up assessment of treatment effects.*
ICF = International Classification of Functioning.

other members of the multidisciplinary team (respiratory nurse, dietician, psychologist, and occupational therapist) should be consulted. After it has been concluded that physical therapy is indicated, it must be determined whether the individual patient can be treated according to the guidelines (or whether motivated deviations are preferred).

Two major domains of symptoms in COPD are of importance for physical therapists: (1) dyspnea, reduced exercise performance and physical activity, and (2) impaired airway clearance. The analysis of exertional dyspnea and the severity and causes of limitations in exercise performance and physical activity is based on the data derived from history-taking, physical examination, pulmonary function tests, maximal incremental exercise tests, and peripheral and respiratory muscle tests. A general approach to identify these limitations is summarized in Supplement 10. Potential candidates for physical therapy are patients with COPD symptoms and impaired quality of life, reduced exercise performance and physical activity in daily life, and muscle weakness. This information is helpful in drawing up the treatment plan for specific physical therapy interventions. Further details for the choice of treatment are discussed in section D.

Analysis of impaired mucus clearance focuses on mucus quality and quantity, and cough efficacy (bronchial obstruction, airway collapse, respiratory muscle strength). Airway collapse resulting from forced expiration should especially be checked for in patients with reduced elastic recoil (emphysema). Typical items in the lung function assessment of these patients are elevated total lung capacity (> 110% of predicted value), functional residual capacity (> 150% of predicted value, reduced Tiffenau index (< 40%) and shape of the forced flow-volume curve. Patients considered eligible for physical therapy interventions are those with copious sputum production, especially if associated with frequent exacerbations. In addition, patients with recurrent exacerbations and impaired airway clearance (bronchiectasis) should also be screened for compliance with instructions for self-management as regards the removal of bronchial secretions.

C.5 Treatment plan

Individual treatment goals are formulated in consultation with the patient, and a treatment plan is drawn up. The general goal of treatment is to reduce or eliminate the patient's body function impairments and to improve activities and participation, thereby improving quality of life. The most common treatment goals for physical therapy interventions are:

1. to reduce dyspnea;
2. to improve exercise capacity and physical activity;
3. to improve mucus clearance;
4. to improve knowledge, self-management and self-efficacy.

In addition to those mentioned above, a patient might experience other health problems, which should be addressed by a multidisciplinary team comprising a pulmonary physician, general practitioner, physical therapist, nurse, nutritionist, psychologist, social worker, and occupational therapist, all qualified in respiratory disease and rehabilitation management. These teams will mostly be based in a secondary or tertiary health care facility, but can also be based in primary care.

D Treatment recommendations

This guideline describes three aspects of the treatment of patients with COPD. The first two are presented on the basis of clinical questions in the two major symptom domains in COPD, viz. dyspnea, reduced exercise performance, and physical activity (section D1) and impaired airway secretions clearance (section D2). The third treatment aspect is that of patient education and self–management (section D3). Section D4 then discusses the evaluation of treatment, and section D5 discusses the completion of treatment.

D.1 Physical training in the context of respiratory rehabilitation

Physical therapy consists of various treatment modalities that are considered cornerstones of the rehabilitation program. The selection of treatment modalities is based on individual treatment goals and the individual causes of exercise limitation. Figure 3 offers a stepwise practical guide to optimize exercise training, starting from the causes of exercise limitation and showing the options for treatment modalities such as interval and endurance exercise training, resistance muscle training, breathing retraining, and respiratory muscle training. The use of additional components during exercise training, such as supplemental oxygen (only on medical prescription), breathing exercises and counseling can also be considered, based on aan evaluation of the exercise limitations.

D.1.1 Types of exercise training

The following sections describe several methods that can be applied to improve exercise performance in patients with COPD. Wherever possible, these are based on the general exercise recommendations of the American College of Sports Medicine for developing cardiorespiratory and muscular fitness and flexibility

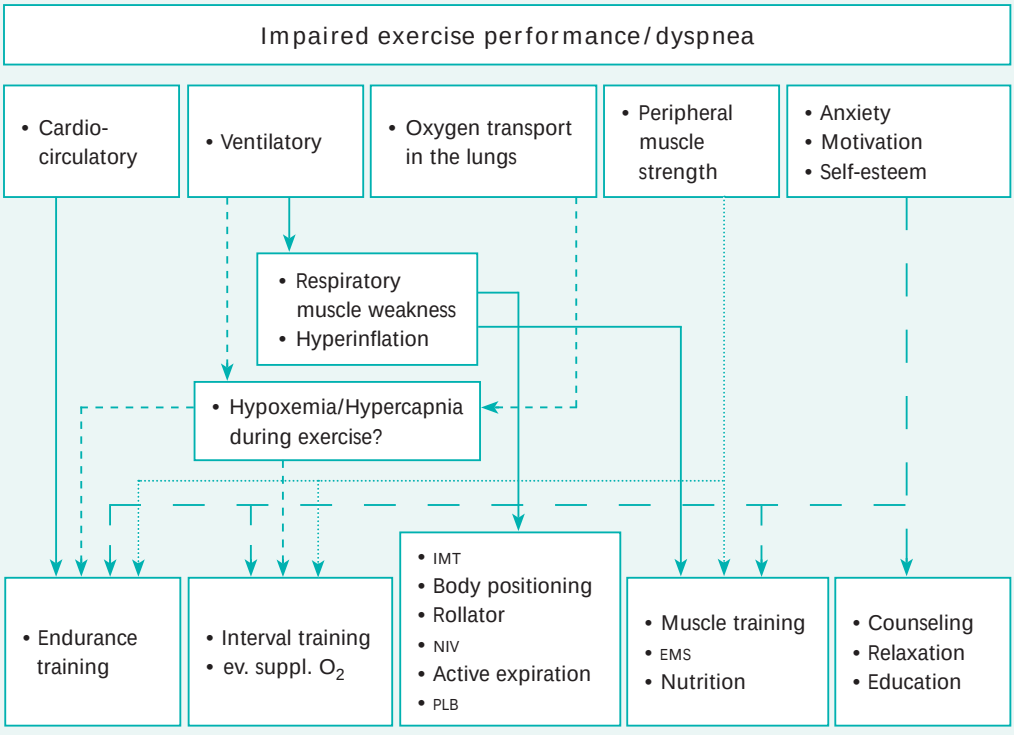

Figure 3. Practice guideline based on the cause(s) of exercise limitation, indicating directions for treatment modalities to optimize exercise performance.
IMT = inspiratory muscle training; NIV = non-invasive ventilation; EMS = electrical muscle stimulation; PLB = pursed lips breathing; ev. = eventually.

Table 5. The American College of Sports Medicine recommendations on exercise parameters for developing cardiorespiratory and muscular fitness, and flexibility in healthy adults.

	Cardiorespiratory fitness	**Muscular strength and endurance**	**Flexibility**
Kind of activity	any activity that uses large muscle groups that can be maintained continuously and is rhythmical and aerobic in nature activities include: walking, cycling, stair climbing, swimming and endurance game activities	resistance training of the major muscle groups of upper and lower limb	stretches for the major muscle groups that should include appropriate static and/or dynamic techniques
Training Frequency	3-5 days per week	2-3 days per week	2-3 days per week
Training intensity	40-60% of heart rate reserve/ VO_{2peak}, or 5-6 on the modified Borg scale	60-80% of the 1RM	
Training duration	20-60 minutes of continuous or intermittent (in sessions lasting 10 or more minutes) aerobic activity	8-15 repetitions multiple set regimens (2-5 sets) may provide greater benefits	4 repetitions, held for 10-30 seconds

1RM = one repetition maximum.

for healthy (elderly) adults, applied to patients with COPD (Table 5). Adjustments to the training strategy, based on the underlying pathophysiology and symptomatology, are required to achieve adequate training stimuli.

Endurance exercise training to improve cardiorespiratory fitness

Endurance exercise training is recommended for COPD patients in all stages of the disease who experience exercise-related restrictions in participation or limitations in daily physical activities. The main objective of endurance training is to improve aerobic exercise capacity. This type of training should enable patients to carry out many daily tasks at a lower relative intensity. Endurance type training is the most successful and least time-consuming treatment to improve aerobic capacity. Training can be performed on a treadmill or on a cycle ergometer.

Interval training

Interval training is recommended as an alternative to endurance training in patients unable to sustain continuous exercise at the desired intensity. Effects are comparable to those of endurance exercise training, provided the total amount of work performed is comparable. Modalities of interval training range from exercise bouts of 30 to 60 seconds at 90 – 100% of the peak work rate achieved in an incremental maximal cycle ergometer test with work/recovery ratios of 1:2, to training sessions lasting 2 to 3 minutes at lower intensities (70% of peak work rate), with work/recovery ratios of 2:1. As long as the total amount of work resembles that of continuous exercise training, it is up to the individual therapist to choose the protocol that seems most suitable. It must be stressed that interval training is considerably more time-consuming than endurance exercise training, due to the regular resting periods. In the first weeks of training, it is recommended to readjust exercise intensity weekly to ensure that the relative exercise intensity remains constant. This will provide an optimal stimulus for peripheral muscle adaptations. Training on a cycle ergometer makes it possible to accurately adjust the intensity of training, based on an initial incremental exercise test. Interval training on a treadmill is also an option, however. In both cases, training intensity should be adjusted using a modified Borg scale.

Resistance muscle training

Resistance training in addition to endurance or interval training is recommended for all patients, and is especially important for patients with peripheral muscle weakness. Resistance training in combination with interval training can be used as an alternative training strategy in patients severely restricted in their ability to perform endurance training due to ventilatory limitations (see flow chart, Figure 3). In the absence of any comparative studies it is recommended to use both upper limb and lower limb resistance weight training at an intensity of at least 60% to 80% of the one-repetition maximum. Two to 3 sets of 8 to 12 repetitions per muscle group are preferred, and training should be conducted at a frequency of 2 to 3 times a week.

Neuromuscular Electrical Stimulation (NMES)
NMES is recommended for patients with severely impaired muscle strength who are not able to participate in regular physical exercises (see Figure 3). It has been shown to result in improvements in muscle force and exercise capacity. Furthermore, it is generally well tolerated, can be implemented at home and is relatively cheap. Further studies are needed to establish its value as an additional intervention in regular exercise programs or even as an alternative training strategy in patients with mild to moderate COPD.

Training of upper extremities
Upper limb exercises are recommended as an additional training modality for patients with reduced upper extremity muscle force experiencing limitations in daily activities that involve upper limb movements. As with other types of resistance training, functional benefits can only be expected in patients experiencing important restrictions in daily tasks that are related to impairments in muscle strength or endurance. Since daily activities consist mostly of carrying free weights, it has been speculated that unsupported exercises are better suited to the daily needs of patients than supported exercises against a fixed resistance (e.g. arm ergometry). No studies have, however, been conducted so far to determine an optimal training mode for upper limb exercises. Most studies have used a combination of resistance and endurance training, emphasizing the strength component.

Intensity of exercise training
There is no consensus about the optimal approach to the intensity of exercise training. However, lower extremity exercise at a high percentage of the peak work rate produces greater physiological effects than training at low intensity. High-intensity endurance training can be prescribed for patients able to tolerate these intensities, or alternatively offered in an interval training program to achieve maximal gains in aerobic and anaerobic capacity. The ASCM recommendations for older adults can be taken as a guideline to determine training intensity. They include a minimum session duration of 20 minutes of effective exercise training. Training load has to be increased gradually over the course of the training program. Ratings of perceived exertion (RPE 5-6/10) or dyspnea on a modified Borg scale can be used to adjust training intensity during the program.

Frequency of exercise training
In the absence of any studies investigating the effects of different training frequencies in COPD patients, training frequencies of 3 to 5 times a week for endurance and interval training and 2 to 3 times a week for resistance training programs are recommended, based on ACSM guidelines. When specified treatment goals have been achieved, maintenance of training effects can be accomplished by training at least once and preferably twice a week, provided that training intensity remains unchanged.

Duration of exercise training programs
Although some studies suggest that beneficial effects persist better with longer programs (lasting more than 12 weeks), shorter programs (4 to 7 weeks) have also resulted in clinically relevant benefits. It is therefore currently not possible to recommend an optimal duration for an exercise training treatment. In determining the appropriate duration of rehabilitation programs, patient characteristics, individual treatment goals and cost-effectiveness have to be taken into account.

Supervision of training
Exercise training should be partly or fully supervised to ensure optimal physiological benefits of exercise training. Whether it is useful to combine supervised programs with self-monitored home-based interventions remains to be investigated in future studies. This approach might enhance physical activity in daily life.

D.1.2 Additional strategies to enhance exercise performance or reduce dyspnea

Breathing exercises
'Breathing exercise' is an umbrella term for a range of exercises which include active expiration, slow and deep breathing, pursed lips breathing, relaxation therapy, body positions such as forward leaning, inspiratory and expiratory muscle training and diaphragmatic breathing. The aims of these exercises vary considerably and include the improvement of regional ventilation and gas exchange, reduction of dynamic hyperinflation, improvement of respiratory muscle function, reduction of dyspnea and improvement of exercise tolerance and quality of life.

Inspiratory muscle training (IMT)
In the absence of conclusive evidence, it is recommended to use IMT as an adjunct to whole body exercise training in selected patients (GOLD II-IV) with symptoms of significantly reduced inspiratory muscle strength and dyspnea during daily activities, as well as fatigue. It is further recommended as a stand-alone treatment for patients with similar characteristics who are unable to effectively participate in whole body exercise because of comorbid conditions. Intensity of the (controlled) training load should be at least 30% of the maximal inspiratory pressure. Expiratory muscle training does not seem to add to the effects of inspiratory muscle training.

Body position
Forward leaning seems an effective method to alleviate dyspnea in COPD patients and is also helpful during rollator-assisted ambulation.

Breathing exercises aimed at reduction of (dynamic) hyperinflation and improvement of gas exchange: pursed lips breathing (PLB), slow and deep breathing, and active expiration
Although evidence for the value of PLB, often combined with slower frequency and larger tidal volume and active expiration, is limited, its application, both at rest and during exertion, should be considered in dyspneic patients with more severe COPD (GOLD III-IV) who also have emphysema. This recommendation is supported by clinical experience and pathophysiological mechanisms. Specific attention has to given to avoid excessive work of breathing.

Breathing exercises aimed at improvement of thoraco-abdominal movements: diaphragmatic breathing
Diaphragmatic breathing seems to have no place in the treatment of patients with moderate to severe COPD.

Relaxation exercises
Relaxation exercises may be considered in patients suffering from anxiety and dyspnea.

Training with supplemental oxygen
Patients who are hypoxemic at rest and are receiving long-term oxygen therapy should continue this during exercise training. They will probably need oxygen supplementation exceeding resting levels to prevent desaturation during exercise.
If patients desaturate during exercise, it is generally recommended not to let oxygen saturation fall below 90% during training. It is therefore recommended to use supplemental oxygen during exercise in patients not suffering from resting hypoxemia who desaturate (pulse oximetry oxygen saturation < 90%) during exercise. This has to be prescribed by the patient's doctor.
Based on available studies and observed effect sizes, systematic oxygen supplementation during exercise to enhance training effects is not recommended for patients without major desaturation during exercise.

Helium-oxygen breathing
There is currently no basis to recommend the systematic supplementation of low-density gas mixtures during training sessions with COPD patients.

Non-invasive mechanical ventilation
The available evidence, combined with the potential burden for therapist and patient and the associated costs, is insufficient to recommend the use of assisted ventilation in rehabilitation practice. Larger prospective controlled studies are required to determine if ventilatory assistance will eventually be a useful adjunct to standard exercise protocols.

D.1.3 Acute exacerbations during the exercise training program
It is recommended to apply training strategies that enable patients to resume participation in a rehabilitation program after an acute exacerbation as soon as practicable. Acute exacerbations of COPD represent the most common condition interfering with the exercise program and an important reason for patients to stop their home exercise program or drop out of rehabilitation programs. Interval training, resistance training, or transcutaneous neuromuscular electrical stimulation can be used to immediately reactivate patients and prevent further decline of functional capacity.

D.2 Treatment modalities to improve mucus clearance

Physical therapy employs a variety of methods for improving mucus clearance. Patients are taught mucus clearance techniques that enable them to effectively clear secretions from the airways themselves. Physical activity enhances mucus clearance (in addition to other benefits). Forced expiration (huffing and coughing) is effective and can be used independently by patients. Appropriate self-management seems important to achieve potential long-term benefits (fewer exacerbations, slower deterioration of pulmonary function). Patients should be encouraged to practice these techniques independently from care providers. Patients with COPD and mucus retention who are unable to expectorate mucus effectively and independently should be taught an alternative technique. The physical therapist should choose the most appropriate technique, or combination of techniques, based on observed problems such as lack of expiratory force and tracheo-bronchial collapse. See Table 6. Figure 4 is a practical guideline to select the appropriate treatment modalities for patients with mucus retention.
Other techniques are available for specific patient conditions: postural drainage (for local retention of large amounts of mucus), positive expiratory pressure (for bronchiectasis), insufflator/exsufflator, chest percussion and mechanical vibration (for patients unable to cooperate with active treatment).
Patients with impaired mucus clearance should be stimulated to participate in physical activities and exercise (in addition to other interventions), to enhance mucus transport. If coughing or huffing does not result in the expectoration of mucus, it may be possible to promote mucus transport by using forced expiration techniques in combination with postural drainage or manual chest wall compression. Postural drainage can be an additional intervention when large amounts of mucus are being retained. Manual compression during coughing or huffing can be considered in COPD patients with expiratory muscle weakness. Manual vibration or percussion is not considered an effective technique to enhance mucus clearance. There is insufficient evidence to support the use of PEP in patients with COPD, though it might be helpful in chronic bronchitis patients (GOLD II-IV) with excessive mucus production. The efficacy of the Flutter technique has not been thoroughly studied in COPD patients and can therefore currently not be recommended.
Although the use of postural drainage, chest percussion or vibration, and positive expiratory pressure has not been unequivocally substantiated by the literature, various combinations of

Table 6. Main treatment options for improving mucus clearance.

- If airway collapse develops, expiratory (compressive) force is too high or lung volume too low. The risk of collapse can be prevented by having the patient cough or huff with less expiratory force and start at a larger lung volume.
- Coughing and huffing require adequate abdominal muscle strength. If there are indications that strength is insufficient, external pressure can be applied, such as manual pressure exerted by the physical therapist or the patient.
- The stimulus of coughing can cause a tickling cough and bronchospasm in susceptible patients. This can be counteracted by using as little force as possible. If this remedy is insufficient, medication use should be re-evaluated.

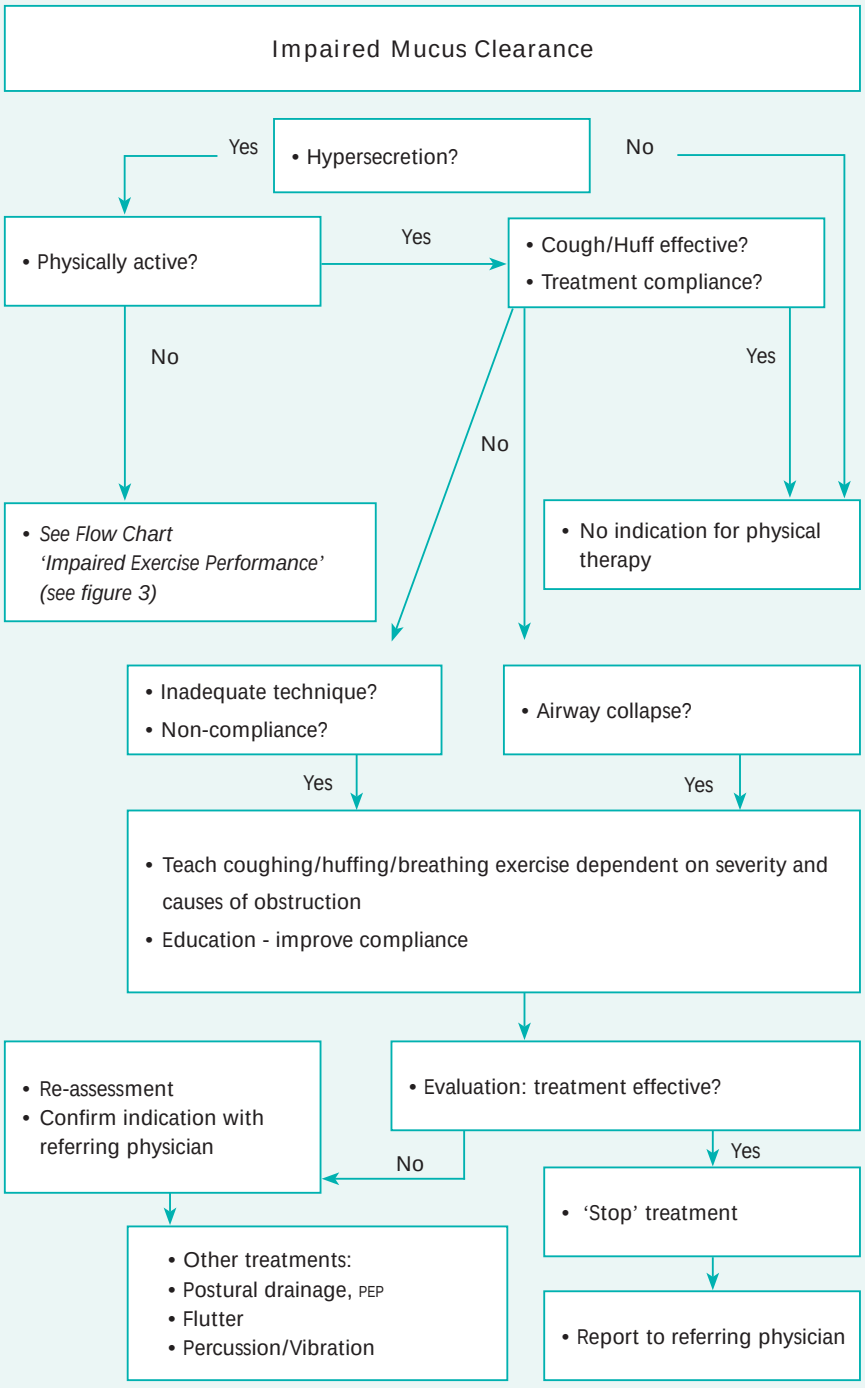

Figure 4. Flow chart for the selection of treatment modalities for patients with mucus retention.
PEP = positive expiratory pressure.

these techniques may be effective in individual patients. If these procedures have not proved effective after 6 sessions, their continued use is no longer meaningful.
Effective procedures for mucus clearance should lead to the expectoration of mucus, or to an improvement in breathing sounds, either during treatment or within 30 minutes after treatment. The treatment goal will have been achieved when the patient is able to clear mucus independently.

D.3 Patient education and self-management

Patient education to enhance compliance and improve self-management skills should be an integral part of the physical therapy treatment for COPD. Promoting changes in daily physical activity by COPD patients during the training period is important. The physical therapy plan should not only prescribe therapies to improve exercise capacity and mucus clearance, but should also include a collaborative problem-solving approach

to help patients systematically develop the self-regulatory skills necessary for their transition from rehabilitation to maintaining an independent active lifestyle. The aim of the intervention is that patients achieve the levels of physical activity needed to improve and maintain health, as recommended for older adults by the American College of Sports Medicine and the American Heart Association.

Recommendations for physical activity to promote health in older adults

To promote and maintain health, older adults need moderate-intensity aerobic physical activity for a minimum of 30 minutes on 5 days a week or vigorous-intensity aerobic physical activity for a minimum of 20 minutes 3 times a week. It is also possible to meet these recommendations by engaging in several bouts of activity lasting at least 10 minutes. The activity can consist of lifestyle activity* or structured exercise or sports, or a combination of these. Moderate and vigorous intensity should be determined relative to an individual's aerobic fitness. On a modified Borg scale of perceived exertion this would correspond to exercising at an intensity of 5 to 6 out of 10 for moderate and 7 to 8 out of 10 for vigorous intensity. This recommended level of aerobic activity should be added to routine activities of daily living.

Across studies among normal and diseased older adults, the behavior modification strategy that has produced the most consistent effects in increasing participation in physical activities in daily life is self-monitoring. Interventions are more successful when they include collaborative goal-setting, strategies to overcome barriers and progress monitoring. Short questionnaires or motion sensors can be used during physical activity interventions to facilitate follow-up assessment and self-monitoring of behavior change. It is suggested to implement effective interventions based on the 5A's behavior-change scheme. See Table 7.

An example of a simple questionnaire to screen patients for inactivity is provided in Supplement 3. Techniques of motivational interviewing can be used to motivate patients to change their physical activity behavior in the interest of their own health. Motivational interviewing is a consulting style that avoids therapist and patient getting caught up in long counseling sessions. The physical therapist should help the patient to explore ambivalence as regards behavior change and finally assist them in expressing their own arguments for change. An example of the way to start a conversation based on these principles, as well as scales to assess motivation for change and confidence about success are provided in Supplement 4.

After assessment, information and agreeing on an action plan, the fourth and fifth A's (Assist and Arrange follow-up) are of critical importance. These can be perfectly implemented in a physical therapy treatment plan, since the therapist has sufficient time to establish a collaborative relationship with the patient over the course of several consultations. Activity diaries, pedometers or more advanced equipment are potentially useful as self-monitoring and feedback tools during these interventions. Regular follow-up sessions should be arranged in order to evaluate results and discuss problems or barriers arising during the process of behavior change.

Patient education is a responsibility shared between the patient, primary care physician, specialist, and non-physician health care providers, while also involving the patient's family. Supplement 11 summarizes the subjects that might be covered in patient education.

D.4 Evaluation

The treatment should include repeated assessment of progress in terms of symptoms, muscle strength, exercise performance, physical activity in daily life, and self-management (including mucus clearance efficacy), in order to monitor treatment progress. Assessment instruments suitable for follow-up are listed in Table 4. Although in most patients, the first signs of improvement appear in the first weeks of treatment, progress might be hampered in some patients by severe deconditioning, interference with acute exacerbations, a prolonged period of habituation to the exercise modalities, musculoskeletal symptoms, psychosocial conditions, or medical conditions. In this situation, the therapist should consult the referring physician, or other members of the multidisciplinary team, and/or adjust the training modalities (interval training, supplemental oxygen, adding respiratory muscle training, use of rollator; see Figure 3) or the strategies to enhance mucus clearance (see Figure 4).

** Lifestyle activity means activities that are performed as part of everyday life, such as climbing stairs or brisk walking.*

Table 7. The five steps of behavioral change.

1.	Assessing	physical activity status, ability and readiness to change.
2.	Advising	on potential benefits of behavior change and the amount, intensity, frequency, and type of physical activity needed to achieve these benefits.
3.	Collaborative Agreement	with patients on a plan of action and identifying personal barriers to the plan.
4.	Assisting	patients in the identification of strategies to overcome personal barriers to physical activity change.
5.	Arranging	for follow-up assessment, feedback, and support.

D.5 Completion of treatment and aftercare

At some point during treatment, and definitely at the end of treatment, the referring physician should be informed about the goals of treatment, the treatment carried out and the results obtained in the individual patient. See table 8. The available data support the recommendation to arrange regular follow-up care for patients on completion of rehabilitation programs and to remain alert during and after periods of acute exacerbation. These acute exacerbations seem to be important triggers for inactivity and result in physical deconditioning in these patients. The goal of aftercare is to ensure that the benefits of therapy persist. Patients who receive aftercare in a group can derive additional benefits from the contact with peers. The most feasible and cost-effective approach for these types of interventions remains to be identified in future studies. In the Netherlands, the Royal Dutch Society for Physical Therapy (KNGF), Dutch Asthma Foundation (Nederlands Astma Fonds), and Netherlands Organization for Applied Scientific Research (TNO) have developed a physical activity program for COPD patients. This program involves participation (whether individual or in a group) in tailored physical activities, sports, and leisure activity. Peer contact plays an important role in maintaining the newly learned physical activity behavior. These programs are supervised by physical therapists qualified in COPD rehabilitation.

Table 8. Main aspects of aftercare.

- Long term adherence will improve when patients continue to practice in group sessions and select forms of physical activity they enjoy.
- Scheduling regular check-ups during after-care increases the patient's motivation to maintain the behavioral change and the state of health achieved.

E Qualification – Equipment – Collaboration

Effective and successful treatment of COPD patients is a team effort. A multidisciplinary team comprises a pulmonary physician, general practitioner, physical therapist, nurse, nutritionist, psychologist, social worker, and occupational therapist, all qualified in respiratory disease and rehabilitation management. These teams will mostly be based in a secondary or tertiary health care facility, but smaller teams (including general practitioner, nurse, physical therapist and nutritionist are also based in primary care. Supplement 12 summarizes the requirements for the physical therapist and the equipment needed for the treatment of COPD patients.

F Legal status of the guidelines

Guidelines are not statutory regulations, but offer insights and recommendations, based on the results of scientific research. Health care workers should implement them in order to provide high-quality care. Since the recommendations are mainly based on the 'average patient', the health care workers have to use their professional judgment to deviate from the guidelines if the patient's situation requires this. Any deviation from the recommendations should be motivated and supported by evidence. The responsibility for the interventions remains with the individual physical therapist.

Acknowledgement

KNGF would particularly like to express its gratitude to Mr. J.B. Wempe, PhD, Mr. W.I. de Boer, PhD, Mr. R.M.M. Geyer, PhD and Ms. M.R. Kruyswijk for their major contributions to the formulation of this Guideline.

Inclusion in the list of reviewers does not imply that each referent agrees with every detail of the guideline.

Supplements

Supplement 1 Conclusions and Recommendations

Explanatory notes

The levels of evidence for the recommendations, based on literature data, have been defined in national agreements (EBRO/CBO). These distinguish 4 levels, depending on the quality of the articles on which they are based:

1 one systematic review (A1) or at least two independent studies of A2 quality;
2 at least two independent studies of B quality;
3 one study of A2 or B quality or several C-quality studies;
4 expert opinion, e.g. the opinion of the members of the working group.

Quality levels (intervention and prevention)

A1 Systematic reviews including at least some studies of A2 quality, with findings consistent across individual studies.
A2 Randomized comparative clinical trials (RCTs) of sound methodological quality (randomized, double-blind, controlled trials), with sufficient size and consistent findings.
B Randomized comparative clinical trials (RCTs) of moderate quality or insufficient size; other comparative studies (non-randomized, comparative cohort studies, case-control studies).
C Non-comparative studies.
D Expert opinion, e.g. opinion of the members of the working group.

Summarized recommendations

Based on the conclusions of scientific research and other considerations, the Working Group has formulated the following summarized recommendations:

1 Measuring and quantifying relevant parameters

The working group recommends measuring and quantifying the relevant parameters not only when taking clinical decisions but also during patient follow-up.

2 Endurance exercise training to improve cardiorespiratory fitness

Endurance exercise training is recommended for COPD patients in all stages of the disease who experience exercise-related restrictions in ADL and social participation. If social and psychological aspects of the disease are having a significant impact on patients' quality of life, they must be referred to multidisciplinary rehabilitation programs.
Quality level of articles: A2 (Cockroft et al., 1981[1]) and B (McGavin et al., 1977[2]; Lake et al., 1990[3]; Booker, 1984[4]; Jones et al., 1985[5]; Troosters et al., 2000[6] and Larsson et al., 1999[7]), B (Hernandez et al., 2000[8] and Troosters et al., 2000[6]) and D (opinion of working group).

3 Interval training

Interval training is an alternative to endurance exercise training, especially suitable for patients who are unable to exercise continuously over longer periods of time. The clinical studies described above examined exercise bouts lasting 30 to 60 seconds at 90 to 100 percent of the peak work rate achieved during an incremental maximal cycle ergometer test with work/recovery ratios of 1:2. Others described exercise bouts lasting 2 to 3 minutes at lower intensity (70% of peak work rate) with work/recovery ratios of 2:1.[4,9] In the absence of comparative studies, it is impossible to conclude that one is better than the other. As long as the total amount of work resembles that of continuous exercise training, it is up to the individual therapist to choose a protocol that seems most suitable.
Quality level of articles: A2 (Puhan et al., 2006[10]) and B (Coppoolse et al., 1999[11]; Vogiatzis et al., 2002[12] and 2005[13]).

4 Resistance muscle training versus usual treatment in a control group

Resistance muscle training is recommended for all patients to supplement endurance exercise training or interval training. The intervention is especially useful for patients with peripheral muscle weakness. A combination of resistance muscle training and interval training can be used as a training strategy for patients who are severely restricted in their ability to engage in endurance exercise training due to ventilatory limitations. In the absence of any comparative studies it is recommended to use both upper limb and lower limb resistance muscle training at an intensity of at least 60% to 80% of the one-repetition maximum (1RM). The working group recommends 2 to 3 sets of 8 to 12 repetitions per muscle group, at a frequency of 2 to 3 times a week.
Quality of articles: A2 (Bernard et al., 1999[14]) and B (Clark et al., 2000[15]; Simpson et al., 1992[16]; Casaburi et al., 2004[17]; Ries et al., 1988[18]; Ortega et al., 2002[19]; Normandin et al., 2002[20]; Wurtemberger & Bastian, 2001[21]; Spruit et al., 2002[22] and Mador et al., 2004[23]).

5 Neuromuscular electrical stimulation (NMES)

NMES is recommended for patients with severely impaired muscle strength who are unable to engage in traditional physical exercise programs. It appears likely that NMES improves muscle force and exercise capacity. The method is generally well tolerated, is relatively cheap and can be administered at the patient's home. Further research is required to establish its value as an additional intervention in regular exercise programs or even as an alternative training strategy for patients with mild to moderate COPD.

Quality of articles: B (Bourjeily-Habr et al., 2002[24]; Neder et al., 2002[25]; Zanotti et al., 2003[26] and Vivodtzev et al., 2006[27]).

6 Training of upper extremities

Upper extremity training is recommended as an additional training modality for patients with reduced upper extremity muscle force experiencing limitations in daily activities that involve upper limb movements. As with other types of resistance training, functional benefits can only be expected in patients experiencing important restrictions in ADL tasks that are related to impairments in muscle strength or endurance. No studies have, however, been conducted so far to determine an optimal training mode for upper limb exercises. Most studies have used a combination of resistance and endurance training, emphasizing the strength component.

Quality of articles: B (Lake et al., 1990[3]; Ries et al., 1988[18]; Bauldoffet al., 1996[28]; Epstein et al., 1997[29]; Martinez et al., 1993[30] and Holland et al., 2004[31]).

7 Intensity of exercise training

There is no consensus about the optimum training intensity. Most centers have patients exercise at the highest attainable percentage (approx. 60%) of their peak work rate. High-intensity endurance exercise training can be prescribed for patients able to tolerate these intensities. Alternatively, a high-intensity interval training programme can be prescribed to achieve maximum gains in aerobic and anaerobic capacity. The recommendations of the ACSM for older adults can be taken as a guideline to determine training intensity. These include a minimum session duration of 20 minutes of effective exercise training. Training load has to be increased gradually over the course of the training program. Ratings of perceived exertion (RPE 5-6/10) or dyspnea can be used to adjust training intensity during the program.

Quality of articles: B (Casaburi et al., 1991[32]; Puente-Maestu et al., 2000[33] and Normandin et al., 2000[20]) and C (Casaburi et al., 1997[34]; Maltais et al., 1997[35] and Zacarias et al., 2000[36]).

8 Frequency of exercise training

In the absence of any studies comparing the effects of different training frequencies in COPD patients, training frequencies of 3 to 5 times a week for endurance training and 2 to 3 times a week for resistance muscle training programs are recommended. When specified treatment goals have been achieved, maintenance of training effects can be accomplished by training at least once and preferably twice a week, provided that training intensity remains unchanged.

Quality of articles: D (work group opinion).

9 Duration of exercise training program

Although some research findings suggest that beneficial effects persist better with longer programs, shorter programs (4 to 7 weeks) have also resulted in clinically relevant benefits. It is therefore currently not possible to recommend an ideal duration for an exercise training program. In determining the appropriate duration of rehabilitation programs, patient characteristics, individual treatment goals and cost-effectiveness have to be taken into account.

Quality of articles: A2 (Griffiths et al., 2000[37]; Ries et al., 1995[38]; Troosterset al., 2000[6]; Lacasse et al., 2006[39]; Salman et al., 2003[40] and Berry et al., 2003[41]) and B (Guell et al., 2000[42] and Green et al., 2001[43]).

10 Supervision of training

Exercise training should be partly or fully supervised to ensure optimal physiological benefits. Whether it is useful to combine supervised programs with self-managed home-based interventions remains to be investigated in future studies.

Quality of articles: B (Puente-Maestu et al., 2000[33]).

11 Inspiratory muscle training (IST)

In the absence of conclusive evidence, it is recommended to use IMT as an adjunct to a respiratory rehabilitation program in selected patients (GOLD II-IV) with symptoms of significantly reduced inspiratory muscle strength, fatigue and dyspnea during daily activities. It is further recommended as a stand-alone treatment for patients with similar characteristics who are unable to effectively participate in whole body exercise because of comorbid conditions. Intensity of the (controlled) training load should be at least 30% of the maximal inspiratory mouth pressure. Expiratory muscle training does not seem to add to the effects of inspiratory muscle training, and is therefore not recommended.

Quality of articles: A2 (Lötters et al., 2002[44], Geddes et al., 2005[45] and Hill et al., 2006[46]) and B (Scherer et al., 2000[47]; Weiner et al., 2003[48] and 2003[49]).

12 Body position

Forward leaning seems an effective method to alleviate dyspnea in COPD patients and is also helpful during rollator-assisted ambulation.

Quality of articles: C (Sharp et al., 1980[50]; Druz & Sharp, 1982[51] and O'Neill & McCarthy, 1983[52]; Sharp et al., 1980[53]; Banzett et al., 1983[54] and Probst et al., 2004[55]).

13 Pursed lips breathing (PLB)

Although evidence for the value of PLB is limited, its use should be considered for emphysema patients perceiving dyspnea, for instance during specific exertions like walking up stairs. This view is supported by both clinical experience and pathophysiological mechanisms.

Quality of articles: B (Tiep et al., 1986[56]; Spahija et al., 2005[57] and Breslin, 1992[58]) and C (Ingram & Schilder, 1967[59]; Mueller et al., 1970[60]; Thoman et al., 1966[61]; Petty & Guthrie, 1971[62] and Bianchi et al., 2004[63]) and C (Mueller et al., 1970[60] and Bianchi et al., 2004[63]).

14 Slow and deep breathing

The use of slow and deep breathing may be considered for patients with a rapid and superficial breathing pattern, although excessive work of breathing should be avoided.

Quality of articles: C (Bellemare & Grassino, 1983[64]).

15 Active expiration

The use of a combination of active expiration and PLB may be considered for patients with severe COPD (GOLD III–IV), both at rest and during exertion.

Quality of articles: B (Reybrouck et al., 1987[65]) and C (Erpicum et al., 1984[66]).

16 Diaphragmatic breathing

Diaphragmatic breathing seems to have no place in the treatment of patients with moderate to severe COPD.

Quality of articles: B (Gosselink et al., 1995[67]) and C (Sackner et al., 1984[68]; Grimby et al., 1975[69]; Willeput et al., 1983[70] and Vitacca et al., 1998[71]).

17 Relaxation exercises

Relaxation exercises may be considered in patients suffering from anxiety and dyspnea.

Quality of articles: B (Renfroe, 1988[72]; Gift et al., 1992[73]; Tiep et al., 1986[56] and Kolaczkowski et al., 1989[74]).

18 Training with supplemental oxygen

In view of the discrepant findings of various studies and the limited number of studies available, it is difficult to draw unequivocal conclusions. Hence, it is not possible to recommend the systematic use of oxygen suppletion during training to enhance treatment effects in patients who do not desaturate during exercise.[75-77] If patients do desaturate during exercise, it is generally recommended not to let oxygen saturation fall below 90%. It is therefore recommended to use supplemental oxygen during exercise in patients not suffering from resting hypoxemia who desaturate (oxygen saturation < 90%) during exercise.

Patients who are hypoxemic at rest and are receiving long-term oxygen therapy should continue this during exercise training. They will probably need oxygen supplementation exceeding resting levels to prevent desaturation during exercise.

Quality of articles: A1 (Bradley et al., 2007[78]), B (Emtner et al., 2003[79]; Rooyackers et al., 1997[80]; Garrod et al., 2000[81] and Wadell et al., 2001[82]) and D (working group's opinion).

19 Training with helium-oxygen breathing

There is currently no basis to recommend the supplementation of low-density gas mixtures during training sessions with COPD patients.

Quality of articles: B (Johnson et al., 2002[83]).

20 Non-invasive mechanical ventilation

The available evidence, combined with the potential burden for therapist and patient, means that the use of assisted ventilation in rehabilitation practice cannot be recommended. Larger prospective controlled studies are required to determine if ventilatory assistance can be a useful adjunct to respiratory rehabilitation programs.

Quality of articles: B (Van't Hul et al., 2006[84]; Costes et al., 2003[85]; Hawkins et al., 2002[86]; Johnson et al., 2002[83] and Bianchi et al., 1998[87]).

21 Acute exacerbations during the rehabilitation program

It is recommended to apply training strategies that enable patients to resume participation in a rehabilitation program after an acute exacerbation as soon as practicable. Interval training, resistance training or NMES can be used to immediately reactivate patients and prevent further decline of functional capacity.

Quality of articles: B (Puhan et al., 2005[88]) and D (working group's opinion).

22 Coughing, huffing and autogenic drainage

Patients with COPD and mucus retention must be taught the appropriate technique to effectively remove secretions. It is the physical therapist's task to select the appropriate technique or combination of techniques on the basis of clinical observations such as lack of expiratory force and tracheo-bronchial collapse. Patients should be encouraged to use these techniques without supervision.

Quality of artyicles: A2 (Jones & Bowe, 2000[89]) and B (Van der Schans et al., 1996[90] and Savci et al., 2000[91]).

23 Manual compression of chest wall and abdomen

Manual compression during coughing or huffing may be considered for patients with expiratory muscle weakness.

Quality of articles: B (Sivasothy et al., 2001[92]).

24 Postural drainage

Postural drainage is a potential additional intervention for the treatment of mucus retention.

Quality of articles: C (Fink, 2002[93] and Sutton et al., 1983[94]).

25 Exercise

In addition to other interventions, COPD patients with impaired mucus clearance should be stimulated to engage in physical activities and exercise to enhance mucus transport.

Quality of articles: C (Oldenburg et al., 1979[95]).

26 Chest percussion and vibration

Manual vibration is not an effective technique to improve mucus clearance.

Quality of articles: D (working group's opinion).

27 Positive expiratory pressure (PEP)

There is as yet insufficient evidence to support the use of PEP for COPD patients, though the technique may be useful for patients with chronic bronchitis (GOLD II-IV) with excessive mucus production.

Quality of articles: A2 (Christensen et al., 1990[96]) and B (Bellone et al., 2002[97]).

28 Flutter

Since the effectiveness of Flutter has not been thoroughly investigated among patients with COPD, it can currently not be recommended.

Quality of articles: B (Bellone et al., 2000[98]).

29 Maintaining effects of therapy / follow-up

The only recommendations that can be made on the basis of the literature data is to arrange regular follow-up after the rehabilitation program has been completed and to remain alert during periods of acute exacerbations. These acute exacerbations seem to be important triggers for inactivity and result in physical deconditioning in these patients. The most feasible and cost-effective approach for these types of interventions remains to be identified in future studies.
Quality of articles: B (Ries et al., 2003[99] and Heppner et al., 2006[100]).

30 Encouraging permanent lifestyle changes

The physical therapy plan should not only prescribe therapies to improve exercise capacity and mucus clearance, but should also include a collaborative problem-solving approach to help patients systematically develop the self-regulatory skills necessary for their transition from rehabilitation to maintaining an independent active lifestyle, for instance by systematically adding specific activities to their daily or weekly planning . Short questionnaires or motion sensors can be used during physical activity interventions to facilitate follow-up assessment and self-monitoring of behavior change. It is suggested to implement effective interventions based on the 5A's behavior-change scheme. Regular follow-up should be arranged to stimulate long-term maintenance of the behavior change.
Quality of articles: B (Atkins et al., 1984[101] and De Blok et al., 2006[102]).

31 Patient education

Education has to be an integral part of the physical therapy treatment of patients with COPD.
Quality of articles: D (working group's opinion).

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Supplement 2 Details of history-taking

Noting the patient's symptoms and current condition

- Reasons for referral; medical referral data (lung function and, where applicable, incremental maximal exercise test); comorbidity (cardiovascular disease).
- How does the patient perceive the consequences of COPD? What are the patient's expectations of treatment (physical therapy)?
- Social data (family composition, occupation, relevant family history).
- Effects of the current condition on emotional functioning.
- Which medication is the patient using and is he or she knowledgeable about their use?
- Treatment by other health professionals?

Clinical signs of reduced exercise capacity/physical activity

- What is the patient's current level of activity? (MRC scale, Table 1)
- Has physical activity changed as a result of the disorder or developments in the disorder (especially recent acute exacerbations)?
- What is the reason for and the extent of the reduction in exercise capacity?
- Does dyspnea or fatigue occur? If so, when? Pattern of physical activity?

Clinical signs of impaired mucus clearance

- Coughing? If so, is coughing productive and effective?
- Increased sputum production? If so, how much? Color and viscosity of sputum?
- Any relationship between sputum production and body posture, activity or medication use?
- Is the patient familiar with expectoration techniques?
- Does mucus retention have any negative effects (e.g., exacerbations, recurrent infection, or fatigue)?

Other symptoms

- Hypoxemia, insomnia, morning headaches, or difficulty concentrating?
- Complaints associated with respiratory movement (e.g., restricted movement, pain or stiffness)?
- Pain associated with deep breathing or coughing?

Recording the natural course of the symptoms and condition

- Brief summary of the onset and course of symptoms.
- Notes on therapy, medication, primary care physician or specialist, hospitalizations, previous physical therapy, and other therapies. What were the effects of each type of therapy?

Evaluation of the patient's physical and mental capacity, causes of symptoms, and factors that may influence symptom development

Evaluating capacity

- Comorbidity (e.g., cardiovascular disease, locomotor tract)?
- Falling body weight despite normal food intake (> 5% per month)?
- Quality of the patient's sleep?

Evaluating strain

- What demands does the patient's environment make on him or her?
- What is the patient's level of activity, including general activities, work and hobbies?
- Are there any aggravating factors (e.g., smoking, hyperreactivity, emotional or behavioral factors, or factors in the work environment)?
- What factors reduce symptoms (e.g., resting, specific environmental conditions, or medication use)?
- What is the patient's need for health education or other information?

Supplement 3 Physical Activity Questionnaire

Physical Activity Assessment[1]

(A) *'How many times a week, do you usually do 20 minutes of vigorous physical activity that makes you sweat or puff and pant? (for example, jogging, heavy lifting, digging, aerobics, or fast bicycling)'*

- 3 times/week
- 1 to 2 times/week
- none

Score:
- 4
- 2
- 0

(B) *'How many times a week, do you usually do 30 minutes of moderate physical activity or walking that increases your heart rate or makes you breath harder than normal? (for example, mowing the lawn, carrying light loads, bicycling at a regular pace, or playing doubles tennis)'*

- > 5 times/week
- 3 to 4 times/week
- 1 to 2 times/week
- none

Score:
- 4
- 2
- 1
- 0

Total score A + score B: _____

Score > 4 = 'Sufficiently' active (encourage patient to *keep it up*)
Score 0 tot 3 = 'Insufficiently' active (encourage patient to do *more*)

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Supplement 4 Example Dialogue for Inactive Patients

Ask your patient,
'On a scale from 0 to 10, where 0 is not motivated at all, and 10 is extremely motivated, how motivated would you say you are right now to increase your physical activity?'

(make a mental note of the value)

'If you were to decide to increase your physical activity, how confident are you that you would succeed? If, on a scale of 0 to 10, 0 means that you are not at all confident and 10 means that you are 100% confident you could become more active. What number would you give yourself now?'

(make a mental note of the value)

Then ask your patient a second scaling question,
'For motivation to change why are you at a _____ (the number the patient gave) and not 0?'
The answer to this question is the patient's motives/reasons for change.

Next ask,
'*And for confidence to change why are you at a* _____ (the number the patient gave) *and not 0?*'
The answer to this question is the patient's 'self-efficacy', the positive reasons why change seems possible.

Finally, provide the patient with a brief summary of what you heard and then ask,
'*What do you think the next step is for you?*'

A common response is for the patient to say they don't know or are uncertain. If they do, follow with,
'Let's list what the options are at the moment.
You could:
- *stay as you are and do nothing;*
- *start to increase the amount of physical activity that you do;*
- *use a loan pedometer for x weeks so that we could take a closer look at your physical activity;*
- *consider a further appointment to discuss things in more detail with the nurse/exercise specialist;*
- *consider joining a community exercise program, group or sports club from this list.*

What do you make of these?'

The options can be altered to reflect local provision and opportunities in the community.

In just a few minutes it is possible to encourage the patient to consider why and how they might change their physical activity without feeling as if they are being pushed or coerced into something they are not ready for.

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Supplement 5 Details of the physical examination in patients with dyspnea and impaired exercise capacity

Clinical impression

- General clinical impression (e.g. walking speed, effort, dyspnea, body position, body mass, use of rollator).
- Is the patient's preferred position to lean forward when seated or to support their arms?
- Cyanosis? (color of the face and lips)
- Muscle atrophy or peripheral edema? Is the skin cyanotic, hydrated or atrophic?
- Does breathing at rest take visible effort? (e.g., nasal flaring or spontaneous pursed-lips breathing)
- Does the patient speak fluently or is speech frequently interrupted?

Shape of the chest

- Signs of hyperinflation present?
- Deformities of the chest? (e.g., pectus excavatum, pectus carinatum, or kyphoscoliosis)
- Abnormal shape of the abdominal wall? (e.g., due to obesity or weakened abdominal musculature)

Respiratory movement

- Abnormal respiratory rate or depth of breathing?
- Movement of abdominal wall and chest during inspiration and expiration? (in terms of direction and timing)
- Is there exaggerated elevation of the upper rib cage during initial inspiration? (pump-handle movement)
- Is there inward drawing of the lower rib cage during inspiration? (e.g., Hoover's sign)
- Any asymmetrical rib cage excursions?
- Do changes in respiratory movement occur during transition from supine to sitting position or from sitting to standing position?
- Activity of accessory respiratory muscles during inspiration and expiration at rest?
- Activity of abdominal muscles during inspiration and expiration at rest?
- Tracheal dip, or infraclavicular or supraclavicular fossa visibly drawn in during inspiration?

Measurement of muscle function and exercise capacity

- Inspiratory and expiratory muscle strength
- Peripheral muscle strength
- Walking test
- Cycle ergometer test
- Oxygen saturation (e.g., using a pulse oxymeter

Other measurements

- Dyspnea (e.g., using Borg scale score)
- MRC scale
- Motivation – readiness for change in life style and physical activity

Supplement 6 Details of the physical examination in patients with impaired mucus clearance

Observation

- Evaluation of coughing and huffing techniques. Can the patient cough effectively? Is there pain during coughing?
- Are there deformities of the thorax (e.g., pectus excavatum-carinatum, or kyphoscoliosis)?
- Is the shape of the abdominal wall abnormal (e.g., due to weakened abdominal muscles)?
- Listening to breathing sounds, auscultation and palpation of the chest;
- Does airway collapse occur (during coughing)?
- Assessing the quantity, color and consistency of expectorated mucus.

Muscle testing

1. Abdominal musculature contraction (i.e. strength) during coughing?

Other measurements

2. Simple spirometry (FEV_1, peak expiratory flow rate).

Supplement 7 Global Perceived Effect

1. Completely recovered
2. Much improved
3. Slightly improved
4. No change
5. Slightly worse
6. Much worse

Supplement 8 Clinical COPD Questionnaire

COPD QUESTIONNAIRE

Patiënt number: _____

Date: _____

COPD QUESTIONNAIRE

Please check the number of the response that best describes how you have been feeling during the past week.
(Only one response for each question).

On average, during the past week, how often did you feel:	never	hardly ever	a few time	several time	many time	a great many times	almost all the time
1. Short of breath at rest?	0	1	2	3	4	5	6
2. Short of breath doing physical activities?	0	1	2	3	4	5	6
3. Concerned about getting a cold or your breathing getting worse?	0	1	2	3	4	5	6
4. Depressed (down) because of your breathing problems	0	1	2	3	4	5	6
In general, during de past week, how much of the time:							
5. Did you cough?	0	1	2	3	4	5	6
6. Did you produce phlegm?	0	1	2	3	4	5	6
On average during the past week, how limited were you in these activities because of your breathing problems?	not limited at all	very slightly limited	slightly limited	moderately limited	very limited	extremely limited	totally limited/ or unable to do
7. Strenuous physical activities (such as climbing stairs, hurrying, doing sports)?	0	1	2	3	4	5	6
8. Moderate physical activities (such as walking, housework, carrying things)?	0	1	2	3	4	5	6
9. Daily activities at home (such as dressing, washing yourself)?	0	1	2	3	4	5	6
10. Social activities (such as talking, being with children, visiting friends/relatives)?	0	1	2	3	4	5	6

Supplement 9 Chronic Respiratory Questionnaire

Mc Master University
Canada

Chronic Respiratory Questionnaire

Self-Administered Standardized Format

(CRQ-SAS)

First Administration

Date ☐☐ ☐☐ ☐☐☐☐
Day Month Year

Chronic Respiratory Questionnaire (CRQ)-SAS-1st Administration 1 (10)

This questionnaire is designed to find out how you have been feeling during the last 2 weeks. In the first section, you will be asked to answer questions about activities which make some people feel short of breath. In the next section, you will answer questions about your mood and how you have been feeling.

- Please read these instructions for completing this questionnaire: Please read each question carefully and then place an 'x' in the box beside the answer that best describes you.
- If you are unsure about how to answer a question, please give the best answer you can.
- If you would like to change an answer, put a line through the box you want to change. Place an 'x' in the box beside the option you would like to choose instead.
- There are no right or wrong answers.
- Your answers to this questionnaire will be kept confidential.

Please continue to the next page.

Date ☐☐ ☐☐ ☐☐☐☐
Day Month Year

CRQ-SAS-1st Administration 2 (10)

Below is a list of activities which make some people with lung problems feel short of breath.
For each of the activities below, place an 'x' in the box that best describes how much shortness of breath you have had while doing that activity during the last 2 weeks.
The last column has been provided for you to indicate if you have not done an activity during the last two weeks.

(Place an 'x' in one box on each line)

Activities	Extremely short of breath	Very short of breath	Quite a bit short of breath	Moderate shortness of breath	Some shortness of breath	A little shortness of breath	Not at all short of breath	Not Done
1. Feeling emotional such as angry or upset	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**
2. Taking care of your basis needs (bathing, showering, eating or dressing)	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**
3. Walking	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**
4. Performing chores (such as housework, shopping, groceries)	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**
5. Participating	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**

Please continue to the next page.

Date ☐☐ ☐☐ ☐☐☐☐
Day Month Year

CRQ-SAS-1st Administration 3 (10)
These next questions ask you about your energy in general and how your mood has been during the last 2 weeks. Please put an 'x' in a box, from 1 to 7, that best describes how your have felt.

6. *In general, how much of the time during the last 2 weeks have you felt frustrated or impatient?*

1. All of the time ☐
2. Most of the time ☐
3. A good bit of the time ☐
4. Some of the time ☐ (Place an 'x' in one box only)
5. A little of the time ☐
6. Hardly any of the time ☐
7. None of the time ☐

7. *How often during the last 2 weeks did you have a feeling of fear or panic when you had difficulty getting your breath?*

1. All of the time ☐
2. Most of the time ☐
3. A good bit of the time ☐
4. Some of the time ☐ (Place an 'x' in one box only)
5. A little of the time ☐
6. Hardly any of the time ☐
7. None of the time ☐

Please continue to the next page.

Date ☐☐ ☐☐ ☐☐☐☐
Day Month Year

CRQ-SAS-1st Administration 4 (10)

8. *What about fatigue? How tired have you felt over the last 2 weeks?*

1. Extremely tired ☐
2. Very tired ☐
3. Quite a bit of tiredness ☐
4. Moderately tired ☐ (Place an 'x' in one box only)
5. Somewhat tired ☐
6. A little tired ☐
7. Not at all tired ☐

9. *How often during the last 2 weeks have you felt embarrassed by your coughing or heavy breathing?*

1. All of the time ☐
2. Most of the time ☐
3. A good bit of the time ☐
4. Some of the time ☐ (Place an 'x' in one box only)
5. A little of the time ☐
6. Hardly any of the time ☐
7. None of the time ☐

Please continue to the next page.

Date ☐☐ ☐☐ ☐☐☐☐
Day Month Year

CRQ-SAS-1st Administration 5 (10)

10. *In the last 2 weeks, how much of the time did you feel very confident and sure that you could deal with your illness?*

1. None of the time ☐
2. A little of the time ☐
3. Some of the time ☐
4. A good bit of the time ☐ (Place an 'x' in one box only)
5. Most of the time ☐
6. Almost all of the time ☐
7. All of the time ☐

11. *How much energy have you had in the last 2 weeks?*

1. No energy at all ☐
2. A little energy ☐
3. Some energy ☐
4. Moderately energetic ☐ (Place an 'x' in one box only)
5. Quite a bit of energy ☐
6. Very energetic ☐
7. Full of energy ☐

Please continue to the next page.

Date ☐☐ ☐☐ ☐☐☐☐
Day Month Year

CRQ-SAS-1st Administration 6 (10)

12. *In general, how much of the time did you feel upset, worried or depressed during the last 2 weeks?*

1. All of the time ☐
2. Most of the time ☐
3. A good bit of the time ☐
4. Some of the time ☐ (Place an 'x' in one box only)
5. A little of the time ☐
6. Hardly any of the time ☐
7. None of the time ☐

13. *How often during the last 2 weeks did you feel you had complete control of your breathing problems?*

1. None of the time ☐
2. A little of the time ☐
3. Some of the time ☐
4. A good bit of the time ☐ (Place an 'x' in one box only)
5. Most of the time ☐
6. Almost all of the time ☐
7. All of the time ☐

Please continue to the next page.

Date ☐☐ ☐☐ ☐☐☐☐
Day Month Year

CRQ-SAS-1st Administration 7 (10)

14. *How much of the time during the last 2 weeks did you feel relaxed and free of tension?*

1. None of the time ☐
2. A little of the time ☐
3. Some of the time ☐
4. A good bit of the time ☐ (Place an 'x' in one box only)
5. Most of the time ☐
6. Almost all of the time ☐
7. All of the time ☐

15. *How often during the last 2 weeks have you felt low in energy?*

1. All of the time ☐
2. Most of the time ☐
3. A good bit of the time ☐
4. Some of the time ☐ (Place an 'x' in one box only)
5. A little of the time ☐
6. Hardly any of the time ☐
7. None of the time ☐

Please continue to the next page.

Date ☐☐ ☐☐ ☐☐☐☐
Day Month Year

CRQ-SAS-1st Administration 8 (10)

16. *In general, how often during the LAST 2 WEEKS have you felt discouraged or down in the dumps?*

1. All of the time ☐
2. Most of the time ☐
3. A good bit of the time ☐
4. Some of the time ☐ (Place an 'x' in one box only)
5. A little of the time ☐
6. Hardly any of the time ☐
7. None of the time ☐

17. *How often during the LAST 2 WEEKS have you felt worn our or sluggish?*

1. All of the time ☐
2. Most of the time ☐
3. A good bit of the time ☐
4. Some of the time ☐ (Place an 'x' in one box only)
5. A little of the time ☐
6. Hardly any of the time ☐
7. None of the time ☐

Please continue to the next page.

Date ☐☐ ☐☐ ☐☐☐☐
Day Month Year

CRQ-SAS-1st Administration 9 (10)

18. *How happy, satisfied, or pleased have you been with your personal life during the last 2 weeks?*

1. Very dissatisfied, unhappy or most of the time ☐
2. Generally dissatisfied, unhappy ☐
3. Somewhat dissatisfied, unhappy ☐
4. Generally satisfied, pleased ☐ (Place an 'x' in one box only)
5. Happy most of the time ☐
6. Very happy most of the time ☐
7. Extremely happy, could not be more satisfied or pleased ☐

19. *How often during the last 2 weeks did you feel upset or scared when you had difficulty getting your breath?*

1. All of the time ☐
2. Most of the time ☐
3. A good bit of the time ☐
4. Some of the time ☐ (Place an 'x' in one box only)
5. A little of the time ☐
6. Hardly any of the time ☐
7. None of the time ☐

Please continue to the next page.

Date ☐☐ ☐☐ ☐☐☐☐
Day Month Year

CRQ-SAS-1st Administration 10 (10)

20. *In general, how often during the LAST 2 WEEKS have you felt restless, tense, or uptight?*

1. All of the time ☐
2. Most of the time ☐
3. A good bit of the time ☐
4. Some of the time ☐ (Place an 'x' in one box only)
5. A little of the time ☐
6. Hardly any of the time ☐
7. None of the time ☐

Thank you

Mc Master University
Canada

Chronic Respiratory Questionnaire

Self-Administered Standardized Format

(CRQ-SAS)

First Administration

This questionnaire is designed to find out how you have been feeling during the last 2 weeks. You will be asked about how short of breath you have been, how tired you have been feeling and yow your mood has been.

I I would like you to think of the activities that you have done during the last 2 weeks that have made you feel short of breath. These should be activities which you do frequently and which are important to you day-to-day life. Please list as many activities as you can that you have done during the last 2 weeks that have made you feel short of breath.

[Circle the number on the answer sheet adjacent to each activity mentioned if an activity is not on the list, write it, in the respondent's own words, in the space provided.]

Can you think of any other activities you have done during the last 2 weeks that have made you feel short of breath?

[Record additional items.]

II I will now read a list of activities which make some people with lung problems feel short of breath. I will pause after each item long enough for you to tell me if you have felt short of breath doing that activity during the last 2 weeks. If you haven't done the activity during the last 2 weeks, just answer 'NO'. The activities are:

[Read items, omitting those which respondent has volunteered spontaneously. pause after each item to give respondent a chance to indicate whether s/he has been short of breath while performing that activity during the last week. circle the number adjacent to appropriate items on answer sheet.]

1. Being *angry* or upset
2. Having a *bath* or shower
3. *Bending*
4. *Carrying*, such as carrying groceries
5. *Dressing*
6. *Eating*
7. *Going* for a walk
8. Doing your *housework*
9. *Hurrying*
10. *Making* a bed
11. *Mopping* or scrubbing the floor
12. *Moving* furniture
13. *Playing* with children or grandchildren
14. *Playing* sports
15. *Reaching* over your head
16. *Running*, such as for a bus
17. *Shopping*
18. While trying to *sleep*
19. *Talking*
20. *Vacuuming*
21. *Walking* around your own home
22. *Walking* uphill
23. *Walking* upstairs
24. *Walking* with others on level ground
25. *Preparing* meals

III Of the items which you have listed, which is the most important to you in your day-to-day life? I will read through the items, and when I am finished, I would like you to tell me which is the most important.
[Read through all items spontaneously volunteered and those from the list which patient mentioned.]

IV Which of these items is most important to you in your day-to-day life?
[list items on response sheet – this becomes activity #1]

V Of the remaining items, which is the most important to you in your day-to-day life? I will read through the items, and when I am finished, I would like you to tell me which is the most important.
[read through remaining items – this becomes activity #2]

VI Of the remaining items, which is the most important to you in your day-to-day life?
[list items on response sheet – this becomes activity #3]

VII Of the remaining items, which is the most important to you in your day-to-day life?
[list items on response sheet – this becomes activity #4]

VIII Of the remaining items, which is the most important in your day-to-day life?
[list items on response sheet – this becomes activity #5]

Please continue to the next page.

[for all subsequent questions, ensure respondents have appropriate response card in front of them before starting question]

I would now like you to describe how much shortness of breath you have experienced during the last 2 weeks while doing the five most important activities you have selected.

1 Please indicate how much shortness of breath you have had during the last 2 weeks while *[interviewer: insert activity #1]*, by choosing one of the following options from the card in front of you. *[green card]*

1 extremely short of breath
2 very short of breath
3 quite a bit short of breath
4 moderate shortness of breath
5 some shortness of breath
6 a little shortness of breath
7 not at all short of breath

2 Please indicate how much shortness of breath you have had during the last 2 weeks while *[interviewer: insert activity #2]*, by choosing one of the following options from the card in front of you. *[green card]*

1 extremely short of breath
2 very short of breath
3 quite a bit short of breath
4 moderate shortness of breath
5 some shortness of breath
6 a little shortness of breath
7 not at all short of breath

Please continue to the next page.

3 Please indicate how much shortness of breath you have had during the last 2 weeks while *[interviewer: insert activity #3]*, by choosing one of the following options from the card in front of you. *[green card]*

1 extremely short of breath
2 very short of breath
3 quite a bit short of breath
4 moderate shortness of breath
5 some shortness of breath
6 a little shortness of breath
7 not at all short of breath

4 Please indicate how much shortness of breath you have had during the last 2 weeks while *[interviewer: insert activity #4]*, by choosing one of the following options from the card in front of you. *[green card]*

1 extremely short of breath
2 very short of breath
3 quite a bit short of breath
4 moderate shortness of breath
5 some shortness of breath
6 a little shortness of breath
7 not at all short of breath

Please continue to the next page.

5 Please indicate how much shortness of breath you have had during the last 2 weeks while *[interviewer: insert activity #5]*, by choosing one of the following options from the card in front of you. *[green card]*

1 extremely short of breath
2 very short of breath
3 quite a bit short of breath
4 moderate shortness of breath
5 some shortness of breath
6 a little shortness of breath
7 not at all short of breath

6 In general, how much of the time during the last 2 weeks have you felt frustrated or impatient? Please indicate how often during the last 2 weeks you have felt frustrated or impatient by choosing one of the following options from the card in front of you. *[blue card]*

1 all of the time
2 most of the time
3 a good bit of the time
4 some of the time
5 a little of the time
6 hardly any of the time
7 none of the time

Please continue to the next page.

7 How often during the last 2 weeks did you have a feeling of fear or panic when you had difficulty getting your breath? Please indicate how often you had a feeling of ear or panic when you had difficulty getting your breath by choosing one of the following options from the card in front of you. *[blue card]*

1 all of the time
2 most of the time
3 a good bit of the time
4 some of the time
5 a little of the time
6 hardly any of the time
7 none of the time

8 What about fatigue? How tired have you felt over the last 2 weeks? Please indicate how tired you felt over the last 2 weeks by choosing one of the following options from the card in front of you. *[orange card]*

1 extremely tired
2 very tired
3 quite a bit of tiredness
4 moderately tired
5 somewhat tired
6 a little tired
7 not at all tired

Please continue to the next page.

9 How often during the last 2 weeks have you felt embarrassed by your coughing or heavy breathing? Please indicate how often you felt embarrassed by your coughing or heavy breathing by choosing one of the following options from the cad in front of you. *[blue card]*

1 all of the time
2 most of the time
3 a good bit of the time
4 some of the time
5 a little of the time
6 hardly any of the time
7 none of the time

10 In the last 2 weeks, how much of the time did you feel very confident and sure that you could deal with your illness? Please indicate how much of the time during the last 2 weeks you felt very confident and sure that you could deal with your illness by choosing one of the options from the card in front of you. *[yellow card]*

1 none of the time
2 a little of the time
3 some of the time
4 a good bit of the time
5 most of the time
6 almost all of the time
7 all of the time

Please continue to the next page.

11 How much energy have you had in the last 2 weeks? Please indicate how much energy you have had by choosing one of the following options from the card in front of you. *[pink card]*

1 no energy at all
2 a little energy
3 some energy
4 moderately energetic
5 quite a bit of energy
6 very energetic
7 full of energy

12 In general, how much of the time did you feel upset, worried or depressed during the last 2 weeks? Please indicate how much of the time you felt upset, worried or depressed during the last 2 weeks by choosing one of the options from the card in front of you. *[blue card]*

1 all of the time
2 most of the time
3 a good bit of the time
4 some of the time
5 a little of the time
6 hardly any of the time
7 none of the time

Please continue to the next page.

13 How often during the last 2 weeks have you had complete control of your breathing problems? Please indicate how often you felt you had complete control of your breathing problems by choosing one of the following options from the card in front of you. *[yellow card]*

1 none of the time
2 a little of the time
3 some of the time
4 a good bit of the time
5 most of the time
6 almost of the time
7 all of the time

14 How much of the time during the last 2 weeks did you feel relaxed and free of tension? Please indicate how much of the time you felt relaxed and free of tension by choosing one of the following options from the card in front of you. *[yellow card]*

1 none of the time
2 a little of the time
3 some of the time
4 a good bit of the time
5 most of the time
6 almost all of the time
7 all of the time

Please continue to the next page.

15 How often during the last 2 weeks have you felt low in energy? Please indicate how often during the last 2 weeks you have felt low in energy by choosing one of the following options from the card in front of you. *[blue card]*

1 all of the time
2 most of the time
3 a good bit of the time
4 some of the time
5 a little of the time
6 hardly any of the time
7 none of the time

16 In general, how often during the last 2 weeks have you felt discouraged or down in the dumps? Please indicate how often during the last 2 weeks you felt discouraged or down in the dumps by choosing one of the following options from the card in front of you. *[blue card]*

1 all of the time
2 most of the time
3 a good bit of the time
4 some of the time
5 a little of the time
6 hardly any of the time
7 none of the time

Please continue to the next page.

17 How often during the last 2 weeks have you felt worn out or sluggish? Please indicate how much of the time you felt worn out or sluggish by choosing one of the following options from card in front of you. *[blue card]*

1 all of the time
2 most of the time
3 a good bit of the time
4 some of the time
5 a little of the time
6 hardly any of the time
7 none of the time

18 How happy, satisfied or pleased have you been with your personal life during the last 2 weeks? Please indicate how happy, satisfied or pleased you have been by choosing one of the following options from the card in front of you. *[grey card]*

1 very dissatisfied, unhappy most of the time
2 generally dissatisfied, unhappy
3 somewhat dissatisfied, unhappy
4 generally satisfied, pleased
5 happy most of the time
6 very happy most of the time
7 extremely happy, could not be more satisfied or pleased

Please continue to the next page.

19 How often during the last 2 weeks did you feel upset or scared when you had difficulty getting your breath? Please indicate how often during the last 2 weeks you felt upset or scared when you had difficulty getting your breath by choosing one of the following options from the card in front of you. *[blue card]*

1 all of the time
2 most of the time
3 a good bit of the time
4 some of the time
5 a little of the time
6 hardly any of the time
7 none of the time

20 In general, how often during the last 2 weeks have you felt restless, tense or uptight? Please indicate how often you have felt restless, tense or uptight by choosing one of the following options from the card in front of you.

1 all of the time
2 most of the time
3 a good bit of the time
4 some of the time
5 a little of the time
6 hardly any of the time
7 none of the time

Thank you

Date ☐☐ ☐☐ ☐☐☐☐
Day Month Year

Response sheet

1. being *angry* or upset
2. having a *bath* or shower
3. *bending*
4. *carrying*, such as carrying groceries
5. *dressing*
6. *eating*
7. *going* for a walk
8. doing your *housework*
9. *hurrying*
10. *making* a bed
11. *mopping* or scrubbing the floor
12. *moving* furniture
13. *playing* with children or grandchildren
14. *playing* sports
15. *reaching* over your head
16. *running*, such as for a bus
17. *shopping*
18. while trying to *sleep*
19. *talking*
20. *vacuuming*
21. *walking* around your own home
22. *walking* uphill
23. *walking* upstairs
24. *walking* with others on level ground
25. *preparing* meals

other activities

_____

_____

_____

activity #1 _____

activity #2 _____

activity #3 _____

activity #4 _____

activity #5 _____

Response Sheet *(continued …)*

Question number	Date Date ☐☐ ☐☐ ☐☐☐☐ Day Month Year	Date Date ☐☐ ☐☐ ☐☐☐☐ Day Month Year
1		
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Supplement 10 Global approach for identification of causes of exercise limitation

Response at peak exercise	PaO_2	$PaCO_2$	$D(A\text{-}a)O_2$	HR	VE	Borg (D/E)
cardiocirc. limitation	=	↓	< 2 kPa	> HR_{max}	< 70% MVV (> 15 L/min. BR)	↑ E
ventilatory limitation	↓ / =	↑	< 2 kPa	< HR_{max}	> 70% MVV (< 15 L/min. BR)	↑ D
pulmonary gas exchange	↓	= / ↓	> 2 kPa	< HR_{max}	< 70% MVV (> 15 L/min. BR)	↑ D
peripheral psychogenic	=	= / ↓	< 2 kPa	< HR_{max}	< 70% MVV (> 15 L/min. BR)	↑↑ E
psychogenic limitation	=	=	< 2 kPa	< HR_{max}	< 70% MVV (> 15 L/min. BR)	↑↑ E

$D(A\text{-}a)O_2$ = alveolar-arterial oxygen difference; HR = heart rate at peak exercise; HR_{max} = predicted maximal heart rate: 220 – age (years) ± 10 beats/minute; V_E = minute ventilation at peak exercise; MVV = Maximal Voluntary Ventilation; BR = Breathing Reserve; D = dyspnea-sensation; E = exertion.
All compared to resting conditions: = no change; ↑ increase; ↓ decrease.

Supplement 11 Subjects for patient education

- Breathing strategies*
- Normal lung function and pathophysiology of lung disease
- Proper use of medications, including oxygen supplementation
- Bronchial hygiene techniques*
- Benefits of exercise and maintaining physical activity level*
- Energy conservation and task simplification techniques
- Healthy nutrition
- Avoiding contact with irritants, e.g. by giving up smoking
- Prevention and early treatment of respiratory exacerbations
- Indications for contacting a health care provider
- Leisure, traveling, sexuality
- Coping with chronic lung disease and end-of-life planning
- Anxiety and panic control, including relaxation techniques* and stress management

* Topics properly belonging to the domain of physical therapy.

Supplement 12 Requirements for physical therapist and equipment

Requirements relating to the supervising physical therapist

- at least 3 years of work experience as a physical therapist
- specialized in respiratory physical therapy and exercise therapy
- resuscitation certificate / Basic Life Support
- experience in administering and interpreting:
  - exercise tests (6mwt/shuttle walk test/cycle ergometer test)
  - health assessments (BMI and plicae thickness)
- muscle force assessments (manually, hand-held dynamometer and hand grip force)
- familiarity with Surgeon General's recommendations for physical activity
- experience in drawing up training schemes for patients with COPD
- awareness of the principles of exercise stimulation and phases of behavioral changes
- experience in providing individual exercise counseling
- affinity with the patient population

Requirements concerning the set-up of the exercise facilities

Facilities

Exercise room with enough space (at least 50 m^2 for 4 people); room for warming-up and functional exercises, room for equipment, separate treatment room. The exercise rooms have to be dust- and smoke-free.

For 6-minute walking tests or shuttle walk tests, the training room or corridor needs to be at least 10 m long and 2 m wide. The floor has to be appropriate (slightly elastic, no deep-pile carpet, not too wet, to avoid slipping).

Equipment/material

1. Exercise training equipment (preferably a calibrated cycle ergometer and/or treadmill)
2. Multifunctional strength training devices (for upper limb, lower limb, and trunk training)
3. Balance
4. Measuring staff
5. Plicometer
6. Blood pressure monitor
7. Heart rate monitor
8. Oxygen saturation meter
9. Handheld dynamometer
10. Borg scales (original or modified version) for dyspnea and subjective load
11. Exercise materials for functional training and mobility training
12. For the 6MWT: stopwatch, 2 cones, tape measure, chair

Requirements relating to the implementation

- Opportunity to perform a maximal exercise test near the patient's home, for instance under the supervision of a lung physician, cardiologist, sports physician or exercise physiologist, after referral by a general practitioner.
- Presence of at least 1 in-house emergency officer during group treatment of patients with COPD.
- Test equipment and exercise materials used have to be accurately calibrated and well maintained.
- Accessibility of the practice for chronically disabled people.
- Operational contingency plan in place.
- High-quality first-aid kit present.
- Accessibility for emergency services (ambulance).
- Provision of sufficient information to the patients.
- Close supervision during and after the performance of tests and training activities.
- Liability insurance that covers the above activities.

Supplement 13 Glossary

1RM = one-repetition maximum
6MWD = 6 minute walking distance
ALM = active limb mobilization
BMI = Body Mass Index
BR = breathing reserve
CCQ = Clinical COPD Questionnnaire
CE = continuous exercise
CRQ = Chronic Respiratory Disease Questionnaire
D = dyspnea sensation
$D(A\text{-}a)O_2$ = alveolar-arterial oxygen difference
E = exertion
EMS = electrical muscle stimulation
EMT = expiratory muscle training
EnT = endurance training
FEV = forced expiratory volume
FRC = functional residual capacity
FVC = functional ventilation capacity
HR = heart rate at peak exercise
HR_{max} = predicted maximal heart rate: 220 – age (years) ± 10 beats/minute
HRQoL = health-related quality of life
ICF = International Classification of Functioning
IE = interval exercise
IMT = inspiratory muscle training
IPAQ = International Physical Activity Questionnaire
LLE = lower limb exercise
LLE = lower limb exercise
MCSA = muscle cross-sectional area
MICD = minimal important clinical difference
MRC = Medical Research Council dyspnea (score/scale)
MVC = maximal voluntary contraction
MVV = maximal voluntary ventilation
NIV = non-invasive ventilation
NMES = neuromuscular electrical stimulation
Pdi = transdiaphragmal pressure
PEDro = Physiotherapy Evidence Database
PEP = positive expiratory pressure
PI_{max} = maximal inspiratory mouth pressure
PLB = pursed lips breathing
pred. = predicted
PWR = peak work rate
QF = quadriceps force
QoLRIQ = Quality of life for respiratory illness questionnaire
RCT = randomized controlled trial
RT = resistance training
SD = standard deviation
SGRQ = St George's respiratory questionnaire
SIP_{max} = maximal sustained inspiratory pressure
ss = statistically significant
SWT = Shuttle Walk Test
TDI = transitional Dyspnea index
TLC = total lung capacity
TR = training
ULE = upper limb exercise
VE_{max} = minute ventilation at peak exercise
Vi = minute ventilation
Vt = tidal volume
Vt/TI = mean inspiratory flow

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