Clinical practice guidelines for physical therapy in patients with chronic obstructive pulmonary disease

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Introduction
These guidelines concern the diagnostic and therapeutic processes involved in providing physical therapy for patients with chronic obstructive pulmonary disease (COPD). The decisions made in arriving at Justification of the guideline recommendations are described in detail in the second part of these guidelines, which is entitled “Review of evidence”.

Target group
These guidelines are intended for physical therapists who treat patients who, as a result of COPD, have impaired mucus clearance, whose normal daily life activities are limited by dyspnea, or who have impaired exercise capacity. These physical therapists are expected to have the relevant expertise and the diagnostic and therapeutic skills needed to treat these patients. Depending on the goals of treatment, special facilities or a well-equipped exercise area may be needed for carrying out the diagnostic and therapeutic processes diagnosis and therapy involved in treating these patients.

Definition of COPD
COPD includes the disorders of chronic bronchitis and emphysema. Chronic bronchitis is defined as the presence of continuous bronchial obstruction and of a chronic productive cough that lasts for at least three months in each of two successive years. In making this diagnosis, other causes of chronic coughs should be excluded. Emphysema is present when there is increased lung volume accompanied by destruction of alveolar walls, without fibrosis.

Chronic bronchial obstruction is a key factor in patients with COPD, bringing about complaints such as dyspnea, whether during exercise or at rest or both, and coughing, sputum expectoration, and wheezing. The patient’s general level of fitness deteriorates because of the disorder and its direct and indirect consequences, such as hypoxemia, medication use, immobility and malnutrition. Patients may tend to avoid exercise and this causes their general physiological condition to deteriorate further. Consequently, there may be problems performing normal daily life activities and psychological complaints may develop, which can be expressed in the form of anxiety, depression and lowered self-esteem. In addition, the patient may become socially isolated.

The primary causes of COPD are cigarette smoke and occupational exposure to high-risk substances. In
addition, air pollution, genetic factors and respiratory infections can contribute to the development of symptoms. A poorer prognosis is associated with persistent smoking, increased non-specific hyperresponsiveness, mucus hypersecretion, hypoxemia and weight loss. The exercise capacity of the patient, has a positive impact on survival.

Epidemiology
In the 1960s and 1970s, a number of cohort studies on the prevalence of asthma or COPD were carried out in adults aged up to 65 years in the Netherlands. They did not differentiate between asthma and COPD. The prevalence of COPD in the Dutch population ranges from 13.0–16.8% in men and from 4.5–7.3% in women. On average, 2.2 new COPD patients per 1,000 adults report to primary care physicians each year (i.e., the incidence of COPD), while 20.4 patients out of every 1,000 adults are diagnosed with COPD (i.e., the prevalence of COPD). Both the incidence and prevalence rise with age and both are higher in men than in women. Both are related to the smoking habit.

Position of physical therapy
In the Netherlands, patients are referred to physical therapists by either a primary care physician or a medical specialist. The Dutch College of General Practitioners Nederlands Huisartsen Genootschap (NHG, Dutch College of General Practitioners) has published guidelines on the diagnosis and treatment of adult patients with COPD. With regard to physical therapy, these guidelines only refer to the use of specialized facilities. A better understanding of how physical therapy can be used in this group of patients – for instance, by improving communication between physical therapist and referring physician – is important for increasing the efficiency of care in these individuals.

Diagnosis
Referral
Patients with COPD may be referred for physical therapy after their medication has been optimized. Furthermore, the COPD patients must have resulted in impaired mucus clearance, disability in performing normal daily activities due to dyspnea, impaired exercise capacity, or a combination of these factors. See Table 1.

COPD is accompanied by a range of impairments, disabilities and problems with participation. The patient’s forced expiratory volume in one second (FEV1), a measure of airflow obstruction, is, by itself, not a good predictor of the degree of difficulty the patient experiences. Optimally, the referral documentation should contain data on the severity and nature of the airflow obstruction, the natural course of the disorder, and relevant medical and psychosocial factors. If exercise training is indicated, data from an incremental exercise test at maximum load should be included in the referral data, if the test was carried out. These requirements imply a need for consultation between pulmonary specialists, physical therapists and, if involved, other healthcare specialists.

History-taking
In history-taking, the aim is to gain the clearest picture possible of the patient’s health problem. The physical therapist must determine the patient’s general needs, expectations, degree of motivation, need for information, and (global and local) load and load-bearing capacity, and how the patient is coping with the disorder and its consequences. One component of history-taking is the quality-of-life inventory. Questionnaires such as the Chronic Respiratory Disease Questionnaire (CRDQ) or the St George’s Respiratory Questionnaire (SGRQ) can be used for this purpose. Table 2 details the main points of history-taking. More information is given below in the review of the evidence.

Table 1. Main reasons for referral.

Physical therapy is indicated when, because of COPD, patients:
• have problems coughing up sputum and have recurrent respiratory infections; or
• have breathlessness (dyspnea) and are, therefore, limited in their daily activities, or both.
On the basis of history-taking, generally two problems can be distinguished in these patients: impaired mucus clearance and impaired exercise capacity including dyspnea. In practice, these two problems often occur in combination. Patients may also have additional problems, such as cor pulmonale or hypoxemia, that could influence the type of physical therapy intervention or program selected.

Physical examination

The physical examination is defined as an examination that covers functional impairment and disabilities in normal daily activities. The strategy adopted in the physical examination depends on the health problems found. Tables 3 and 4 describe the main points of the physical examination of patients with impaired mucus clearance and patients with impaired exercise capacity (including dyspnea), respectively. They also describe how data are obtained. More information on the physical examination and the measuring instruments used is given below in the review of the evidence.

Analysis

The results of history-taking and the physical examination, supplemented by medical referral data, provide clear evidence for deciding whether to refer a patient for physical therapy. On the assumption that the referring physician has correctly diagnosed COPD, the following questions should be answered:

- Are any COPD-related health problems present?
- Which functional impairments and disabilities are observable and what problems with participation does the patient experience?
- Which complaints, impairments and disabilities can be affected by physical therapy?
- Is the patient motivated to undergo physical therapy?

On the basis of the obtained data, the physical therapist should be able to determine whether a referral for physical therapy is justified. If there is any

Table 2. Main points of history-taking.

- Record the patient’s symptoms and current condition;
- Determine whether there are any sensations of dyspnea and, if so, whether they are experienced at rest or during exercise;
- Determine whether there are any signs of impaired mucus clearance;
- Determine whether there are any signs of impaired exercise capacity; determine which disabilities in normal daily activities the patient experiences because of the disorder;
- Assess quality-of-life;
- Note the natural course followed by the symptoms and the disorder;
- Note load and load-bearing capability; determine which causal or inhibitory factors are influencing symptoms and their progression;
- Determine the patient’s need for information.

Table 3. Main points of the physical examination of patients with impaired mucus clearance.

<table>
<thead>
<tr>
<th>Information on:</th>
<th>Procedure</th>
<th>Evaluation method</th>
</tr>
</thead>
<tbody>
<tr>
<td>• signs of (severe) obstruction</td>
<td>observation</td>
<td>contraction of scalene muscles, tracheal tug, Hoover's sign</td>
</tr>
<tr>
<td>• the quantity, consistency and appearance of sputum</td>
<td>observation</td>
<td></td>
</tr>
<tr>
<td>• location of sputum</td>
<td>observation and auscultation</td>
<td></td>
</tr>
<tr>
<td>• whether coughing or blowing is productive</td>
<td>observation and listening</td>
<td></td>
</tr>
<tr>
<td>• signs that airways collapse has occurred</td>
<td>observation and listening</td>
<td></td>
</tr>
</tbody>
</table>
If doubt about the severity or nature of the disorder or about any related health problems, the referring physician should be consulted. The patient may need to be referred back for additional diagnosis or to adjust the treatment approach.

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. Patients can be treated according to these guidelines if:

- the referral data is adequate; and
- the patient’s medication has been optimized, as discussed in the NHG guidelines on COPD.

### Table 4. Main points of the physical examination of patients with impaired exercise capacity.

<table>
<thead>
<tr>
<th>Information on:</th>
<th>Procedure</th>
<th>Evaluation method</th>
</tr>
</thead>
<tbody>
<tr>
<td>signs of (severe) obstruction</td>
<td>observation</td>
<td>contraction of scalene muscles, tracheal tug, Hoover's sign</td>
</tr>
<tr>
<td>strength and endurance of skeletal muscle</td>
<td>measurement</td>
<td>handheld dynamometer</td>
</tr>
<tr>
<td>strength and endurance of respiratory muscles</td>
<td>measurement</td>
<td>mouth pressure meter</td>
</tr>
<tr>
<td>general endurance</td>
<td>measurement</td>
<td>12-minute walking test, shuttle test, cycle ergometer endurance test</td>
</tr>
<tr>
<td>dyspnea</td>
<td>measurement</td>
<td>Borg scale, visual analogue scales</td>
</tr>
</tbody>
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Treatment plan

After the above questions have been answered, individual treatment goals are drawn up formulated in consultation with the patient, and a treatment plan is formulated. In rehabilitation, the general goal of treatment is to reduce or eliminate the patient’s impairments, disabilities and problems with participation, thereby improving quality of life. Furthermore, for patients with COPD, the most common treatment goals are:

1. to improve mucus clearance;
2. to improve exercise capacity;
3. to reduce dyspnea; and
4. to promote compliance with therapy.

In addition to those mentioned above, the patient may experience other health problems, which in some cases may be associated with the underlying pulmonary disease. The therapist may deem these problems to be such that further physical therapy is indicated. However, these additional health problems are not covered by these guidelines.

**Therapy**

The therapeutic process is geared to the treatment plan, which, among other things, expresses the most common treatment goals in patients with COPD.

### Table 5. Main points of treatment for improving mucus clearance.

- If airways collapse develops, the compressive force is too great. The risk of collapse can be prevented to the greatest possible extent if the patient coughs or huffs with little force and starts with a large 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 himself or herself.
- 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. Pursed-lips breathing can also be used. If these remedies are insufficient, medication use should be re-evaluated.
Improving mucus clearance

In order to improve mucus clearance patients are taught techniques that enable them to clear mucus effectively by themselves. Long-term goals are, for example, to ensure that fewer exacerbations of the condition occur and to engender a less rapid deterioration in pulmonary function, as indicated by the FEV₁ value.

For mucus clearance, coughing and blowing are extremely important. The physical therapist should first, therefore, choose to teach techniques for effective coughing and blowing. By adjusting the force used and matching it with the patient’s lung volume, these techniques can be adjusted for the individual patient.

If coughing or huffing does not result in the expectoration of mucus, it may be possible to promote mucus transport using forced expiration techniques in combination with postural drainage. Although the sole use of either postural drainage, chest percussion or vibration, or positive expiratory pressure has not been unequivocally substantiated by the literature, when used in various combinations these techniques may be effective in individual patients. If these procedures prove not effective after six sessions, their continued use is no longer meaningful. Exercise can help some patients clear mucus secretions. To encourage mucus clearance, however, the patient must ventilate substantially. Then, the normal conditions for exercise training apply.

Effective procedures for mucus clearance should lead to the expectoration of mucus, or to a reduction in rhonchi, either during treatment or within 30 minutes after treatment. The treatment goal will have been achieved when the patient is able clear mucus by himself or herself.

Improving exercise capacity

The review of the evidence below describes five reasons for reduced exercise capacity in these patients. The different reasons for reduced exercise tolerance can be distinguished using an incremental exercise test at maximum load that also involves the measurement of blood gas concentrations. In practice, reduced exercise capacity is usually caused by several factors. For didactic purposes, these factors will be discussed separately here. By using the information presented below, the physical therapist can concentrate on certain aspects of treatment depending on the individual patient’s needs.

Exercise capacity can be improved in two main ways: firstly, by increasing efficiency of movement and, secondly, by achieving a physiological training effect. Training aimed at improving exercise capacity should last a minimum of six weeks and a maximum of six months. Training should be given at least three times per week for 20–45 minutes. A physiological training effect occurs when the body has to work against increasing load. To achieve this, a minimum level of intensity must be used (see the discussion on cardiocirculatory limitations below).

1. Cardiocirculatory limitations

In training¹ to increase overall exercise capacity, the general principles for improving physical condition

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¹ The (Dutch) Classification of Procedures for Paramedical Professions (CVPB) uses the terms exercising and guiding.
can be applied. To improve exercise capacity (i.e., to obtain a physiological training effect), one must exercise at least three times a week for 20–45 minutes at 60–80% of maximum heart rate. Sessions may consist of one or more forms of exercise, such as cycling, walking, climbing stairs and rowing. The training effect is specific: in other words, improvement will occur primarily in the activity being trained. This means that the program content must be geared to the desired activity, to the patient’s needs, and to the patient’s main health problems. To retain effects of the treatment after the conclusion of therapy, exercise frequency is reduced to once or twice a week at the same intensity.

2. Ventilatory limitations
In addition to providing a general exercise program, inspiratory muscle training (IMT) can also be given. These two elements are discussed separately.

**General exercise program**
Patients whose exercise capacity is limited by ventilation problems can receive endurance training unless hypoxemia (i.e., an oxygen saturation < 90%) or severe hypercapnia (i.e., an arterial carbon dioxide pressure > 55 mmHg) is present during exercise. Training load is determined by the results of the incremental exercise test, with training aiming for 60–80% of maximum load for an exercise duration of at least 20 minutes. If hypoxemia or severe hypercapnia is present, exercises should be carried out using intervals. Most commonly, sequences of two minutes of exercise followed by two minutes of rest are repeated for a total of, at least, 20 minutes. Even for patients who experience increased obstruction when exercising (e.g., patients with unstable airways), interval training is the correct way of increasing exercise capacity. Some practical examples are circuit training and interval walking or cycling protocols.

**Inspiratory muscle training**
A prerequisite for giving inspiratory muscle training is that the patient has diminished inspiratory muscle strength or endurance. To determine whether this is the case, the physical therapist should measure the maximum inspiratory pressure at the mouth (PI\text{max}). Reference values are given in Note 12 of the notes on diagnosis at the end of the review of the evidence. The appropriate equipment and expertise are required to perform these measurements correctly. The value of PI\text{max} determines the selection of the exercise load. In order to train the inspiratory muscles, there must be some inspiratory resistance. Resistance can be either flow-dependent or flow-independent (i.e., threshold).

To increase the strength and endurance of the respiratory muscles, the patient should exercise twice daily for 15 minutes at a load level of at least 30–40% of PI\text{max}. PI\text{max} must be measured regularly, so that exercise intensity can be adjusted during the exercise program, if necessary. After completion of the exercise program, respiratory muscle strength must be

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**Table 7. Main points of exercise programs for patients with ventilatory limitations.**

- If the form of exercise chosen is different from that used in the incremental exercise test, the baseline exercise level should produce the heart rate reached at 60% of maximum load during the test. One should also take the Borg scale score into account in setting the exercise load.
- In this patient group, hypoxemia can develop during exercise. The incremental exercise test at maximum load could verify this. Since hypoxemia can lead to cardiac arrhythmia, the physical therapist must measure oxygen saturation either regularly or continuously in these patients.

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**Table 8. Main points of respiratory muscle training in patients with a ventilatory limitations.**

- When flow-dependent inspiratory resistance is used, the patient should be given feedback on the pressure and flow rate used to reach the target levels (i.e., target flow rate or target pressure) during training. An in-line pressure gauge or flowmeter can be used for this purpose.
maintained. This can be achieved by exercising at the same intensity 2–3 times a week for two 15-minute sessions.

3. **Oxygen transport limitations**

Oxygen transport limitations can result in desaturation during exercise. Therefore, the physical therapist must measure oxygen saturation regularly or continuously during training. Imminent hypoxemia can be prevented by supplemental oxygen therapy. The administration of oxygen is classified in the same way as providing medication and can only be prescribed by a pulmonary physician, who is then responsible for treatment. Therefore, treatment involving the administration of oxygen should be carried out in specialized facilities. If patients are willing, their training can take place in a primary care facility, provided the physical therapist has an oxymeter to monitor saturation during treatment.

When training to increase exercise capacity in these patients, interval training should be used unless oxygen supplementation is prescribed. Exercise intensity depends on the results of the incremental exercise test. The patient should start with an exercise load at which oxygen saturation is more than 90%, unless otherwise indicated by the pulmonary physician. If supplemental oxygen is given, the target exercise load can be 60–80% of maximum load. In addition to training exercise capacity, the physical therapist may also teach the patient how to use his or her physical capabilities as efficiently as possible. Since this is more a matter of ergonomics, it would be helpful if an occupational therapist specializing in COPD is consulted or cooperates in treatment.

For these patients, the application of ergonomics involves exercises aimed at improving the performance of normal daily activities. In addition, patients can also practice breathing exercises, such as breathing at a slow rate with pursed lips. This may help achieve more effective ventilation and, thereby, a higher oxygen saturation at rest.

4. **Peripheral muscle weakness**

For patients with peripheral muscle weakness, an endurance training program should be given (see the description under cardiocirculatory limitations above) unless hypoxemia (i.e., an oxygen saturation < 90%) or severe hypercapnia (i.e., an arterial carbon dioxide pressure > 55 mmHg) develops, in which case interval training is indicated. Other functions, such as muscle function, velocity, coordination and flexibility, also need to be trained. Exercise load should be at least 60% of maximum load. The target exercise load should be as high as possible for the desired duration. In the training program, additional attention needs to be given to improving the functioning of relevant muscle groups.

In giving exercises to strengthen arm and leg muscles and to improve their endurance, general training principles apply. The patient should train three times a week. A training regimen that emphasizes both strength and endurance is usually employed. An exercise load of about 60% of maximum and exercises involving 10–30 repetitions are appropriate.

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### Table 9. Main points of treatment for patients with oxygen transport limitations.

- If the transfer coefficient (TLco), which indicates the diffusion capacity of the lungs, is less than 50% predicted, the risk of hypoxia occurring during exercise is very high. In these patients, it is essential to pay extra attention to measuring oxygen saturation during exercise.

### Table 10. Main points of treatment for patients with peripheral muscle weakness.

- Good nutrition is important if muscle strength is to be increased. Hypoxemia, inactivity, and, especially, the use of oral corticosteroids all have a negative impact on muscle function. If any of these factors is contributing to peripheral muscle weakness, it should be eliminated or its effects should be reduced. Consultation with the relevant specialist is desirable.
Table 11. Main points of treatment for patients with dyspnea.

- In patients with COPD, the breathing pattern is usually functional. Therefore, the physical therapist must always ensure that any change in breathing movement is an improvement for the individual patient.
- Not all patients find pursed-lips breathing pleasant.

5. Other factors
One other factor that influences exercise capacity is an inadequate breathing pattern due to exercise phobia. The patient might not have been able to achieve his or her maximum performance during the cycle ergometer test because of fear of bronchospasm, dyspnea or stress. In addition, other disorders or diseases may also have this effect.

Patients in this group can be offered an endurance training program (see the description under cardiocirculatory limitations above) unless hypoxemia (i.e., an oxygen saturation < 90%) or severe hypercapnia (i.e., an arterial carbon dioxide pressure > 55 mmHg) develops, in which case periodic training is indicated. Other functions, such as muscle function, velocity, coordination and flexibility, also need to be trained. This patient group should begin with a very low exercise load. However, the exercise load should be at least 60% of maximum load and the target exercise load should be as high as possible for the desired duration. If anxiety or stress is contributing to the reduced exercise capacity, relaxation exercises can be given.

Reducing dyspnea
Dyspnea has multiple causes. In treatment, therefore, it is important to employ a range of different approaches and to determine which is most effective for the individual patient.

Optimizing diaphragm function
The slight contraction of the abdominal muscles during expiration can facilitate diaphragm function. This action positions the diaphragm optimally for the next inspiration, resulting in a better function. In addition, the patient can assume certain body postures that lengthen the diaphragm, enabling it to contract more efficiently. One example is leaning over from a sitting position. The accessory muscles of respiration can provide more force if the arms are anchored in position, for example, if the patient walks with the aid of a rollator walker or uses handrails.

Increasing tidal volume and lowering breathing frequency (at rest)
There are a range of different breathing exercises for increasing the ratio of inspiration time to expiration time. The key is to shorten inspiration relatively and prolong expiration. This process helps patients become aware of their breathing and gives them the sense that they can control it and that they can even contribute to managing their symptoms. Increasing tidal volume and reducing the breathing rate improve alveolar ventilation.

During pursed-lips breathing, the patient exhales gently against slightly pursed lips. This causes the tidal volume to increase and the frequency of breathing to decrease. Some patients may already do this spontaneously.

Increasing the strength and endurance of respiratory muscles
Inspiratory muscle training can reduce dyspnea because it increases the load-bearing capacity of the respiratory muscles. See the discussion of ventilatory limitations above.

Optimizing ergonomic factors
During treatment, it is important to pay attention to ergonomic factors. This can involve giving the advice to alternate periods of efforts with rest. The presence of a severe obstruction can be a reason for deciding to assess whether a patient might benefit from different kinds of mobility aids. This could be done in consultation with a specialized occupational therapist, for instance. Examples of such aids are walking aids (e.g. a rollator walker) or home
adjustments (e.g. the installation of a stairlift).

**Desensitization**
Repeated experiencing of dyspnea, for example, during exercise in a safe environment, can reduce the perception of dyspnea.

**Improving compliance with therapy**
A significant goal in ensuring therapeutic compliance is bringing about behavioral modification. For treatment to have lasting results, patients have to incorporate the functions and skills learned during treatment into their daily lives. For COPD patients, this almost always involves complying with therapy over the long term.

The physical therapist has a role in training the patient in and educating the patient about the behavioral adjustments and modifications required. Patient education should be considered as a means of achieving behavioral modification. Consequently, patient education is a significant aspect of care. A professional approach to patient education presumes knowledge about and understanding of how information can be presented and of the factors that positively or negatively influence the development of the desired behavioral modification.

Before beginning patient education, the patient’s need for information about and training in the new behavior must be assessed. These needs provide the starting point for the education program. Patient education can be subdivided into four categories: information, instruction, education and guidance. In practice, these four categories overlap one another. In each category, activities require different amounts of time, and make different demands on equipment and on the therapist’s skills.

To achieve behavioral change, the patient must pass through six stages:
1. being open to information about the need to change behavior;
2. understanding and remembering the information;
3. wanting to change behavior;
4. being able to perform the modified behavior;
5. actually performing (doing) the behavior; and
6. continuing to perform the behavior over the long term.

Analyzing the process in terms of these different stages helps in achieving an understanding of the problems involved in therapeutic compliance. It is essential for behavioral modification that patients have confidence in their own capabilities (i.e., their self-efficacy) and that the advantages of behavioral modification outweigh the disadvantages. More information is given in the review of the evidence.

**Completion and reporting**
At some point during treatment and, mandatory, at the end of treatment, the referring physician should be informed about the goals of treatment, the treatment carried out and the results of treatment in the individual patient. Communication will also have to take place about the division of responsibilities during rehabilitation and about any necessary consultation with other health professionals.

**After-care**
After treatment has ended, follow-up in the form of providing after-care will be necessary. After-care is
provided on the condition that there are no medical grounds for further treatment. The goal of after-care is to ensure that the benefits of therapy are maintained. Patients who receive after-care in a group can derive additional benefits from contact with peers.

In the Netherlands, the Dutch Asthma Foundation (Nederlands Asthma Fonds) organizes athletic groups for individuals with COPD. These involve participation in specially adapted group sports and games. Peer contact plays an important role in maintaining the newly learned behavior. COPD athletic groups are coached by physical therapists who specialize in COPD. No suitable course of action has yet been found for the category of patients who are not eligible to attend COPD athletic groups (see the exclusion criteria noted in the discussion on after-care in the review of the evidence section).

Table 13. Main points of after-care.

- Over the long term, patients find it easier to continue practicing forms of movement they enjoy. It also appears easier to continue practicing in a group.
- Scheduling check-ups during after-care increases the patient’s motivation to maintain the behavioral change and the state of health achieved.
Review of the evidence

Introduction

The KNGF-Guidelines COPD deals with the physical therapy treatment of patients with Chronic Obstructive Pulmonary Disease (COPD), namely chronic bronchitis and emphysema. The guideline includes the diagnostic and therapeutic process in line with the methodical therapeutic conduct.

Definition

KNGF-guidelines are defined as ‘guidelines whose production is directed by a central body, that are developed systematically, that are written by experts, and that deal with the systematic process of physical therapy in certain health problems and with various (organizational) aspects of the profession’.1,2

Objective of the KNGF-guidelines COPD

The objective of the guidelines is to describe the ‘optimal’ diagnosis and physical therapy treatment – with regard to effectiveness, efficiency and tailored care - for patients who have, due to COPD, impairments in the mucus clearance or who experience disabilities in ADL due to dyspnea or who have exercise limitations. The recommendations are based upon current scientific research, professional and social insights.1-3

Besides the above mentioned goals, the KNGF-guidelines are explicitly meant to:

- Change the care in the desired direction based on current scientific research and improve the quality and the uniformity of this care.
- Assure insight into tasks and responsibilities and to stimulate cooperation.
- Support the process of decision making with regard to the treatment or not and the use of diagnostic and therapeutic interventions.

To make use of the guidelines it is necessary to insure the recommendations of professional requirements.

Presenting the clinical questions

The group which has formulated these guidelines wanted to attain an answer on the following questions:

- Which factors can be influenced by physical therapy?
- What is the objective of physical therapy?
- Which parts of the physiotherapeutic diagnostic assessment are valid, reliable and useful in daily practice?
- Which forms of treatment and prevention are clinical significant?

Formation of the mono disciplinary working group

In July 1996 a mono disciplinary working group of professionals was formed to answer these clinical questions.3 In the formation of the working group an attempt was made to achieve a balance in professionals with experience in the area of concern or with an academic background. All members of the working group have stated that they had no conflicting interests whatsoever in relation to the development of the KNGF-guidelines. The development of the guidelines took place from July 1996 until December 1997.

Procedure of the mono disciplinary working group

The guidelines have been developed according to the ‘Methods for the Development and Implementation of Clinical Guidelines’.1-5 This method includes practical instruction of the strategies used to collect literature. In the continuation of the review of evidence in these guidelines the specific terms used for the search, the sources used, the period in which the literature was published, and the inclusion or exclusion criteria for the literature are mentioned.

For a more extensive description of the different literature searches is referred to the background report: The physical therapeutic interventions in patients with chronic obstructive pulmonary diseases.3

The members of the working group have individually selected and graded the proceedings attaining to the scientific evidence. Even though the scientific evidence is prepared by individuals or by smaller subgroups, the result is laid out and discussed within the whole working group. The scientific evidence is then summarized in a conclusion, including the
extent of the evidence. Besides the scientific evidence there are other important aspects for making the recommendations such as: reaching a general consensus, efficiency (costs), resource availability, necessary expertise and education, organization aspects and the attempt for agreement with other mono or multi disciplinary guidelines.1-3 If there was no scientific evidence available, the recommendations were formulated based upon consensus within the working group or secondary group of professionals. The recommendations are commented on by external professionals. Once the mono disciplinary concept guidelines were completed they were sent to external professionals and/or occupational organizations (secondary working group) to attain a general consensus within the other occupational groups or organizations and/or with other mono and multi disciplinary guidelines. Also the wishes and preferences of patients are taken into account by representation of the Dutch Asthma Foundation.

Validation by the intended users
Before publication and distribution, the guidelines are reviewed and systematically tested by the intended users (validation). The concept of the KNGF-guidelines COPD was sent to a group of 64 physical therapists working in different working environments to judge the guidelines. The comments and remarks from the physical therapists are documented and discussed in the working group and if possible or desired included in the final guidelines. The recommendations for the practice are the result of the available evidence, the above mentioned other aspects and the results of testing the guideline amongst the intended users.

Constitution, products and implementation of the guidelines
The guidelines exist of three parts: the practical guideline, a schematic layout of the main points of the guideline (summary) and the review of evidence section. All parts of the KNGF-guidelines can be read separately. After the publication and distribution of the guidelines amongst members of the KNGF, an article on the most important recommendations has been published6 and a segment promoting professionalism has been developed and published to stimulate the use of the guidelines in daily practice.7 The guidelines are implemented according to a standard of implementation strategies which are described in the method.1-5,8

Nomenclature
Orie et al.9 firstly introduced the term chronic non-specific lung disease (CNSLD) in the 1960s. Sluiter et al.10 continued to use this umbrella term because they believe there is a substantial overlap between the disorders of asthma, chronic bronchitis and emphysema, and furthermore that these conditions have the same pathogenesis and pathophysiology. They hold that the distinction made between these disorders is neither very plausible nor meaningful. In addition to using the term CNSLD, criteria that better delineate the patient group must also be defined.10 Outside the Netherlands, however, the term CNSLD is rarely used.11 Moreover, in recent years, there have been increasing indications that there is a great difference between the disorders of asthma and COPD. Any confirmed distinction between asthma and COPD would have a significant impact on therapy and prognosis.12,13

Introduction to these guidelines
Target group
Specific and demonstrable knowledge and skills are required for adequately treating patients with COPD. The necessary knowledge and skills can be obtained by having extensive experience working with these patients or through continuing education, which should include learning about pathology, the mechanics of breathing, general training principles, measuring instruments, and the interpretation of incremental exercise test results. The special requirements placed on the treatment environment and equipment used should also be covered. The treatment area must be clean and well-ventilated. There must also be an area where patients can rest for short periods, change their clothing and wash. A mouth pressure meter is required for testing and training inspiratory muscle strength. Equipment for exercise training includes a treadmill or cycle ergometer, exercise apparatus, an exercise mat, and a pulse oximeter.14 When treating patients with impaired oxygen transport, equipment for oxygen supplementation must be available. This equipment
Defining COPD

The American Thoracic Society uses the following definitions. Chronic obstructive pulmonary disease (COPD) is characterized by airflow obstruction due to chronic bronchitis or emphysema. The, partially reversible, obstruction tends to be progressive and may be associated with airway hyper reactivity. Chronic bronchitis is defined as the presence of a chronic productive cough that lasts for at least three months in each of two successive years. In making this diagnosis, other causes of chronic coughs should be excluded. Emphysema is present when there is abnormal permanent enlargement of the lung accompanied by destruction of alveolar walls, without fibrosis.

Pulmonary function tests can be useful in making a diagnosis and in indicating the severity of the disorder. The European Respiratory Society states that measuring the forced expiratory volume in one second (FEV₁) provides an indication of the severity of the disorder. The American Thoracic Society has used FEV₁ to indicate the different stages of COPD, as shown in Table 14.

Table 14. Two classifications of COPD severity based on measurement of forced expiratory volume in one second (FEV₁).

<table>
<thead>
<tr>
<th>European Respiratory Society</th>
<th>mild</th>
<th>FEV₁ (% of predicted value)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>≥ 70%</td>
</tr>
<tr>
<td>moderately severe</td>
<td></td>
<td>50–69%</td>
</tr>
<tr>
<td>severe</td>
<td></td>
<td>35–49%</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>American Thoracic Society</th>
<th>phase 1</th>
<th>phase 2</th>
<th>phase 3</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>35–49%</td>
<td>&lt; 35%</td>
<td></td>
</tr>
</tbody>
</table>

Although FEV₁ is used to indicate the severity of pulmonary disease, this measure has not been found to be a good predictor of quality of life or of the disabilities experienced by patients. Various trials have shown that there is only a weak relationship between pulmonary function and health-related quality of life in COPD patients. Williams et al. found a weak correlation between pulmonary function and disabilities, and a strong correlation between dyspnea and disabilities. Okubadejo et al. studied the correlation between FEV₁ and the results of using the St George’s Respiratory Questionnaire (SGRO), the Sickness Impact Profile, and the Hospital Anxiety and Depression Scale. Only the relationship between activity on the SGRO and FEV₁ was found to be significant. In general, levels of anxiety and depression were found to be better predictors of quality of life than physiological parameters.

COPD mainly affects people in middle age. Common symptoms are dyspnea with coughing, wheezing, sputum production, and recurrent respiratory infection. Compared to persons in a normal cross-section of the population, COPD patients have more disabilities in their daily life. A Dutch study of 50 COPD patients found that 46% were unable or only partly able to hold a job or keep house because of their condition. In addition, patients were handicapped in carrying out physical activities involving exertion. Problems with mobility, vitality and sleep, and emotional problems such as depression and anxiety were also experienced. Social problems took the form of difficulties in performing housework and leisure activities, and reduced social interaction.

Causes

The prevalence of coughing and sputum production is higher in smokers, who also exhibit a greater annual decline in FEV₁. In addition, the mortality rate due to copd is higher in smokers. Increased smoking accelerates the decline in FEV₁, whereas ceasing smoking slows the decline in FEV₁. A study carried out by Kauffmann et al. showed that occupational exposure to certain materials was
related to decreased FEV1. Heederik at al.31 found relationships between occupational exposure to certain substances, such as smoke, dust and metals, and respiratory symptoms and pulmonary function disorders. In addition, there are several other factors that may be associated with COPD, such as air pollution (both indoor and outdoor), passive smoking, socioeconomic status, genetic factors, respiratory infection, allergy, bronchial hyperresponsiveness, age and sex.32

**Prognosis**

In the medical literature, a connection is usually made between prognosis and survival. The strongest predictors of mortality are age and FEV1. The higher the patient’s age and the lower his or her FEV1, the worse the prognosis.33,34 After correcting for age and FEV1, total lung capacity, heart rate at rest, and the degree of physical limitations and disabilities experienced all appear to correlate positively with mortality. Exercise capacity appears to have a negative correlation with mortality.13

Chronic mucus hypersecretion is related to a more rapid decline in FEV1 and is a predictor of death from respiratory infections in COPD patients.34 Weight loss is also associated with a poorer prognosis.35

Postma et al.36 established that deterioration in FEV1 is determined by the degree of bronchial hyperresponsiveness, the reversibility of bronchial obstruction, and whether the patient ceases smoking. The more severe the hyperresponsiveness, the more rapid the deterioration. The better the reversibility, the slower the deterioration. Smoking cessation has a positive effect on survival and on FEV1 decline over time.

**Epidemiology**

The most extensive longitudinal cohort study on the prevalence of COPD, in which no distinction was made between asthma and COPD, was conducted between 1965 and 1969 in the Netherlands: the Vlagtwedde-Vlaardingen study.37 Another study, the Zoetermeer Epidemiological Preventive Study was carried out between 1976–1978.38 These trials found that the prevalence of COPD in men varies from 13.0–16.8% and, in women, from 4.5–7.3%.

In the period 1985–1988, morbidity records were maintained by Dutch primary care physicians at the Nijmegen University Primary Practice Institute. These showed that the incidence and prevalence of COPD is higher in men than women and that both measures increase with age in both sexes. In men, the incidence increases from 0.2 per 1,000 in the 25–34 year age group to 24.4 per 1,000 in those aged 75 years and older; in women, from 0.4 per 1,000 in the 25–34 year age group to 4.2 per 1,000 in those aged 75 years and older. In men, the prevalence increases from 6.6 per 1,000 in the 25–34 year age group to 233.9 per 1,000 in those aged 75 years and older; in women, from 4.0 per 1,000 in the 25–34 year age group to 43.9 per 1,000 in those 75 years and older.38 These figures probably give underestimates because not all COPD patients are registered with their primary care physician as having the condition.

Combining these figures from the Nijmegen University Primary Practice Institute with the demographic changes expected in coming years indicates that an increase in the number of COPD patients can be anticipated in the future, particularly in the 45–64 year age group.38

**Work absenteeism**

The average duration of sick-leave in the Netherlands is 22 days, when calculated from all cases of illness notified to companies. The average illness durations for patients with chronic bronchitis and emphysema are 77 and 167 days, respectively.39 In 1985, the total number of sick-leave days due to obstructive pulmonary disease comprised 1.18% of all days lost because of diagnosed sickness in the Netherlands, which was 612,100. Of those, 167,000 sick-leave days were due to chronic bronchitis and 61,100 to emphysema.39 These data only cover cases of sick-leave known to company organizations and to employers who, either jointly or as a group bear the medical insurance risk on an ongoing basis.

**Position of physical therapy**

In the Netherlands, patients can be referred to physical therapists by primary care physicians or medical specialists. The Dutch College of General Practitioners (NHG) recently revised its primary care
guidelines for the diagnosis and treatment of COPD patients. With regard to physical therapy, these guidelines only refer to the use of specialized facilities. However, recent trials on the outcome of physical therapy have found that it deserves a role in the treatment of patients with asthma and COPD.\textsuperscript{40-42}

Only 1.7% of all physical therapy work carried out in the primary care sector involves patients with breathing problems.\textsuperscript{43} This is also consistent with data on the referral policies of primary care physicians: 89.0% of COPD patients are not referred to other practitioners by primary care physicians, 9.0% are referred to specialists, and only 1.8% are referred to physical therapists.\textsuperscript{44} Possible reasons for the small number of physical therapy referrals are that primary care physicians may be relatively unfamiliar with the forms of diagnosis and treatment that physical therapists can provide for COPD patients, and that primary care physicians may judge the severity of obstructive pulmonary disease solely on the basis of pulmonary function.\textsuperscript{45} This may occur despite the fact that pulmonary function is a poor predictor of quality of life and is a poor indicator of the quality of life, perceives disabilities or exercise capacity,\textsuperscript{46} and of the level of dyspnea. Having a physical therapy consultation before referral is considered could provide a way of clarifying the need for physical therapy. The introduction of a consultative physical therapy examination is one way of improving the efficiency of care.\textsuperscript{47} The primary care physician’s requirements from consultation can also better be satisfied by a physical therapist who has extensive experience or who is well-trained, or both.\textsuperscript{47} In addition, the present guidelines can also contribute to increasing understanding of how physical therapy can be used, thereby leading to more specific referrals and to more knowledge of the possibilities of physical therapy treatment.

In 1991, a study carried out at the secondary care level in the Netherlands found that 3% of the total number of COPD inpatients in a general hospital were receiving treatment from physical therapists.\textsuperscript{48} No data are available on the intervention the physical therapists used with these patients in either primary or secondary care, nor on the severity of the disorders or the patients’ needs.

**Pathophysiology**

Bronchial obstruction is the core complaint in patients with COPD. It can be caused by swelling of the mucosa, the accumulation of mucus, loss of elasticity of the lung parenchyma, or bronchospasm. These phenomena can occur in various combinations.

**Severity of bronchial obstruction**

Bronchial obstruction can be quantified by measuring dynamic pulmonary function parameters. In particular, the maximum forced expiratory volume in one second (FEV\textsubscript{1}) is useful. In its more severe form, COPD may be associated with hyperinflation. In this situation, the thorax is in a position characteristic of inspiration when the patient is at rest. Hyperinflation can result in a thoracic breathing pattern and an increased load on respiratory muscles. Some clinical observations related to the severity of obstruction are: contraction of the scalene muscles, tracheal tug (i.e., downward movement of the trachea during inspiration), and Hoover’s sign (i.e., inward movement of the costal wall of the lower ribs during inspiration). There are significant correlations between these symptoms and FEV\textsubscript{1}.\textsuperscript{41} Inter-assessor reliability is fair for observations of intercostal retraction of the intercostal spaces, tracheal tug on inspiration, and Hoover’s sign (Kappa minimum = 0.50, p < 0.0001 for all three symptoms).\textsuperscript{49}

The typical problems affecting COPD patients that also influence physical therapy are discussed sequentially below.

**Impaired mucus clearance**

Mucus retention is very common in patients with COPD. It can cause bronchial obstruction. In turn, mucus retention can be caused by increased mucus secretion or by impaired mucus transport.

Richardson and Peatfield.\textsuperscript{50} give an overview of mechanisms that can increase mucus secretion. The inhalation of dust or cigarette smoke increases mucus secretion, and inhaling antigens that stimulate inflammatory processes increases mucus production. Impaired mucus transport may be the result of reduced mucociliary clearance or reduced expiratory airflow. Research carried out by Goodman et al.\textsuperscript{51} shows that smoking can result in inactive cilia.
Recurrence infection can lead to a loss of ciliated epithelium. The contribution airflow makes to mucus transport depends on expiratory airflow velocity, which is determined by the magnitude of the airflow and bronchial tube diameter. Effective mucus transport occurs at high airflow velocities. To achieve this, airflow must be large and the total airway cross-section must be small.

Peripheral airway obstruction restricts airflow in the peripheral airways. In turn, reduced airflow in the peripheral airways slows airflow in the central respiratory tracts. This process could diminish the efficacy of mucus transport caused by expiratory airflow.

Mucus retention can cause pathological changes in the lungs, possibly because of recurrent respiratory infection. It can even contribute to the progression of pulmonary disease. The presence of hypersecretion is a risk factor for death from COPD. Hypersecretion leads to a greater annual decline in FEV1 and is a risk factor for hospitalization due to COPD. Physical therapy can help patients use external effort to improve mucus transport to the greatest extent possible and several interventions are available for doing this (see the discussion below on therapy for improving mucus clearance).

**Reduced exercise capacity**

During exercise, muscle metabolism increases resulting in more muscle oxygen consumption and increased carbon dioxide production. Therefore, during exercise, additional oxygen must be transported and additional carbon dioxide must be removed. Folgering and van Herwaarden designate four types of problems that can cause decreased exercise capacity:

1. cardiocirculatory limitations;
2. ventilatory limitations;
3. oxygen transport limitations; and
4. psychogenic limitations.

These different types of limitation can be distinguished with the aid of an incremental exercise test carried out at maximum load, during which blood gas levels are also measured.

**1. Cardiocirculatory limitations**

In patients with mild forms of bronchial obstruction (i.e., FEV1 > 60% of that predicted), reduced exercise capacity may be caused by cardiocirculatory limitations. In these individuals, the circulation cannot transport an adequate amount of oxygen to the muscles. Because of a lack of oxygen, muscles switch to anaerobic metabolism, which involves the production of lactic acid. Cardiocirculatory limitations are demonstrated by the age-related reduction in maximum heart rate (i.e., 220 beats/min minus age in years) and by a blood lactate level of approximately 10 mmol/l. Endurance training can contribute to improving exercise capacity.

**2. Ventilatory limitations**

In patients with moderate to severe forms of obstruction (i.e., FEV1 < 60% of that predicted), the respiratory pump may be overloaded by hyperinflation, dynamic collapse, or other factors. The presence of ventilatory limitations is indicated by increased arterial carbon dioxide pressure (PaCO2) during the incremental exercise test.

Ventilatory limitations can be seen as being due to an imbalance between the load on and the load-bearing capacity of the respiratory muscles. Respiratory muscle load is increased by increased airways resistance and decreased compliance of the lungs and chest wall. At the same time, the strength (i.e., the load-bearing capacity) of the respiratory muscles may be impaired by hypoxemia, hypercapnia, cardiac decompensation, oral corticosteroid use, or malnutrition.

By measuring maximum inspiratory pressure at the mouth (PIm), the physical therapist can obtain a reliable indication of the strength of the inspiratory muscles. The clinical signs of fatigued, or heavily loaded, respiratory muscles are an elevated respiratory rate and, at a later stage, abdominal paradox and respiratory alternans. (Abdominal paradox is inward movement of the abdominal wall during inspiration and respiratory alternans is alternation between a thoracic and abdominal breathing pattern.) Respiratory muscle fatigue can cause respiratory failure, resulting in the development of hypoxemia and hypercapnia. In patients with
ventilatory limitations, the maximum voluntary ventilation threshold can be surpassed at a certain exercise level. However, ventilation can be increased by increasing the tidal volume and by a relative lengthening of the expiration time. To achieve this, the respiratory muscles, including accessory respiratory muscles, must work harder.

Ventilatory capacity can be increased by targeted training of the respiratory muscles. Respiratory muscle function can be improved by increasing the strength or endurance, or both, of the respiratory muscles.

3. Oxygen transport limitations
In patients with oxygen transport limitations, the alveolar capillary membrane surface area is reduced. This causes problems with oxygen diffusion and contact time. In these patients, arterial oxygen tension (PaO₂) drops during submaximal exercise. This can only be detected using an incremental exercise test at the patient’s maximum exercise rate.

This group of patients must learn to use their bodies more efficiently. Breathing exercises aimed at lowering the respiratory rate can reduce the dead space. Furthermore, supplemental oxygen may be necessary to improve the patient’s exercise capacity (68–70). Training with oxygen supplementation improves the condition of the peripheral muscles because the number of capillaries increases and there are more and larger mitochondria, thereby enabling better oxygen extraction to take place. Therefore, better use is made of the limited amount of oxygen present.

4. Psychogenic limitations
If a patient stops the exercise test without having encountered one the above limitations, it can be assumed that the reasons for stopping are psychogenic, for example, anxiety or exercise phobia. In all patients with psychogenic limitations, physical therapy can help reduce the symptoms that limit exercise. In the clinical guidelines above, these limitations are dealt with under the category of other factors.

Recently, a fifth type of problem that can result in reduced exercise capacity has been described, namely:

5. Peripheral muscle weakness
If the leg muscles become rapidly fatigued, the COPD patient’s exercise capacity will be limited. Recent research by Maltais et al. confirms this view. The researchers showed that patients with COPD have reduced aerobic capacity, with the result that lactic acid is produced at an earlier stage during exercise. Gosselink et al. concluded that pulmonary function and peripheral muscle strength are important determinants of exercise capacity in COPD patients. Possible causes of general muscle weakness are cardiac decompensation, corticosteroid use, and an impaired nutritional stage.

Patients with peripheral muscle weakness commonly score very high on the Borg scale for ‘heaviness’ (i.e., leg fatigue), during maximum exercise. In order to confirm that muscle weakness is the reason for stopping exercise, additional examinations should be performed, such as testing quadriceps muscle strength. If the peripheral muscular strength is, at least partly, responsible for reduced exercise capacity, then peripheral muscle training will have to be part of physical therapy. If hypoxemia, steroid therapy or malnutrition contribute to reduced muscle strength, these factors should be minimized or eliminated as far as possible. In this regard, it should be noted that consultation with the practitioners of other disciplines is essential for optimal treatment.

Dyspnea
Dyspnea is the unpleasant subjective sensation of needing to breathe, which may be due to various mechanisms:

- Central respiratory center activity is closely associated with sensations of dyspnea. The respiratory center can be activated by changes in blood gas concentrations, such as an increase in arterial carbon dioxide tension (hypercapnia) or a decrease in arterial oxygen tension (hypoxemia).
- In “length-tension inappropriateness”, patients experience respiration as being mechanically insufficient. In the body, the relationship between the actual change in respiratory muscle length and muscle strength is constantly being evaluated in terms of expected changes in length.
If the length change is smaller than expected, the person experiences dyspnea. This mechanism is especially important when an extra demand is placed on the respiratory apparatus.

- Psychosocial factors: emotional and situational factors can also be associated with the sensation of dyspnea. Fatigue, respiratory muscle weakness, and the fact that the minute ventilation in COPD patients is high all contribute to sensations of breathlessness. When the minute ventilation is high, every increase in the ventilation rate is a relatively large increase, which leads to a proportionally large increase in dyspnea. Dyspnea seems to be affected more by repetitive movements of the upper extremities. This may be explained by the fact that these movements reduce the ability of the upper chest muscles to contribute to respiration. Unilateral arm movements involve less load for the patient than bilateral movements.

**Malnutrition**

An underweight condition (i.e., a weight under 90% of the ideal weight) is common in patients with COPD. Its prevalence increases as the degree of bronchial obstruction increases. The muscular strength of respiratory and skeletal muscles is less in patients who are underweight than in those with a normal weight. Gray-Donald et al. reported that patients who are underweight have a lower maximum exercise capacity but that the condition has no impact on submaximal exercise capacity or dyspnea. In patients with COPD, fat-free body mass is a better indicator of respiratory and skeletal muscle strength than body weight and is a significant determinant of exercise tolerance. A reduction in fat-free body mass is associated with lower values for respiratory and peripheral muscular strength. In one group of randomly selected COPD patients (mean FEV1, 53%), 14% were found to have reduced fat-free body mass and reduced body weight, and 7% were found to have only one of the two. Here again, there is a need for communication between the practitioners of different disciplines because nutritional interventions in underweight patients can increase respiratory and peripheral muscle strength and improve exercise capacity.

**Diagnosis**

The methodical provision of physical therapy is based on a problem-solving approach. Several stages can be distinguished in this process. The starting point is referral by a primary care physician or medical specialist and the patient’s reasons for seeking medical care. The next stage is history-taking, which is followed by an examination of the patient and drawing conclusions, or making a physical therapy diagnosis. In assessing the patient’s needs, the physical therapist must determine whether physical therapy would be helpful. If so, the therapist draws up a treatment plan, which is periodically evaluated during the course of treatment and after treatment ends. The last stage is concluding treatment and reporting back to the referring physician.

**Referral**

The physical therapist must have all the relevant medical and psychosocial data before the patient is examined and, if necessary, treated. These data guide the therapeutic approach and help the physical therapist analyze the patient’s health problems, interpret the examination results, and formulate realistic and attainable treatment goals. An understanding of the severity of the condition and its prognosis is important for making an accurate assessment of the results of physical therapy.

Relevant medical data includes data from pulmonary function tests and, if the physical therapist wants to improve the patient’s exercise capacity, an incremental exercise test at the patient’s maximum exercise rate. According to Cambach et al. certain patients should be treated in special COPD facilities: those whose arterial oxygen tension (PaO2) is lower than 8.6 kPa (65 mmHg) and those whose arterial carbon dioxide tension (PaCO2) is higher than 6.0 kPa (45 mmHg), at rest or during exercise.

**History-taking**

Details of the information sought and the questions asked during history-taking are presented in Table 15.
**Table 15. Details of history-taking in patients with COPD. The raised figures are references to individual notes in the appended notes on diagnosis.**

Noting the patient's symptoms and current condition:
- reasons for referral; medical referral data (nature of obstruction: chronic bronchitis or emphysema);
- patient’s needs. How does the patient experience the consequences of COPD? What are the patient’s expectations of treatment (physical therapy)?
- social data (family composition, occupation, family history);
- effects of the condition on emotional functioning;
- Which medications is the patient using and is he or she knowledgeable about their use?

Are there any signs of impaired mucus clearance?
- Does the patient cough? If so, is coughing productive and effective?
- Is there increased sputum secretion? If so, how much? What is the color and consistency of the sputum?
- Is there a relationship between sputum production and body posture, activity or medication use?
- Is the patient familiar with mobilization and expectoration techniques?
- Does mucus retention have any negative effects (e.g., exacerbations, recurrent infection, or fatigue)?

Are there any indications of reduced exercise capacity due to COPD?
- What is the patient's current level of activity and has it changed as a result of the disorder?
- What is the reason for and the extent of any reduction in exercise capacity?
- Does dyspnea occur? If so, when?

Quality of life questionnaire note 1

Are there any other symptoms?
- hypoxia, hypoxemia, insomnia, morning headaches, or difficulty concentrating?
- Are there any complaints associated with respiratory movement (e.g., restricted movement, pain or stiffness)?
- Is there any pain associated with deep breathing or coughing?
- Is there cardiac decompensation?

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, hospitalization, physical therapy, and other therapies. What were the effects of each type of therapy?

Noting the patient's load and load-bearing capacity, the causes of symptoms, and any factors that have influenced or are influencing symptom development:

Evaluating load-bearing capacity:
- Have any traumas occurred or operations taken place?
- Are there any other disorders (e.g., of the locomotor tract or any other tracts)?
- Has body weight decreased despite normal food consumption?
- What is the quality of the patient’s sleep (e.g., problems with falling asleep or staying asleep)?

Evaluating load:
- 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)?
- Which factors reduce symptoms (e.g., resting, specific environmental conditions, or medication use)?

What is the patient’s need for information? note 2
Table 16. Details of the physical examination in patients with impaired mucus clearance. The raised figures are references to individual notes in the appended notes on diagnosis.

**Observation:**
- evaluation of coughing and huffing techniques. Can the patient cough effectively? Is there pain during coughing? note 3
- Are there deformities of the thorax (e.g., pectus excavatum, pectus carinatum, or kyphoscoliosis)? note 4
- Is the shape of the abdominal wall abnormal (e.g., due to weakened abdominal musculature)? note 5
- auscultation and palpation of thoracic wall; note 5
- listening to breath sounds; note 5
- Does airways collapse occur? note 3
- assessing the quantity, consistency and appearance of mucus.

**Movement testing:**
- How well does the abdominal musculature function (i.e., strength and endurance)? note 3

**Other measurements:**
- peak expiratory flow. note 6

**Physical examination**
The physical examination usually comprises observation and palpation, since these two processes often occur at the same time. Palpation is used to verify the information obtained by observation. The physical examination is divided into two parts in order to investigate two specific problems in patients with COPD. Table 16 describes the details of the physical examination in patients with impaired mucus clearance and Table 17 describes the physical examination in those with impaired exercise capacity.

**Analysis**
During analysis, the patient’s health problem is analyzed using referral data and data obtained from the physical therapy examination. The physical therapist should be able to determine whether physical therapy is indicated, or whether the patient should be referred for consultation elsewhere. Physical therapy is indicated for patients who, because of COPD, have impaired mucus clearance, whose normal daily life activities are limited by dyspnea, or who have impaired exercise capacity. The patient should be motivated to undergo treatment because very active participation is required to achieve good results. After the completion of treatment, the patient must be proactive so that the benefits can be maintained.

Patients can be treated according to these guidelines if their medication has previously been optimized and if the referral data is sufficient. If there are indications that a patient’s medication is not optimal, he or she should be referred back to the physician. If a patient is suffering from disabilities due to reduced exercise capacity, referral documentation should, if it is complete, include data from an incremental exercise test at the patient’s maximum exercise load. These data are essential for determining the patient’s exercise limitations so that the appropriate exercise load can be used and so that the therapist can be sure there are no contraindications. If the patient does not satisfy the requirements for participating in exercise training, the referring physician should be consulted.

**Analysis: impaired mucus clearance**
Patients with impaired mucus clearance may have one or more impairments, such as bronchial obstruction resulting from mucus retention or airways collapse, or a disorder in mucus transport, production, composition or clearance.

Systemic factors that can cause or contribute to impaired mucus clearance include medication use, malnutrition and other problems such as heart ailments. These may necessitate consultation with or treatment by another specialist.

Local factors that can cause or contribute to impaired mucus clearance must also be taken into
Table 17. Details of the physical examination in patients with impaired exercise capacity. The raised figures are references to individual notes in the appended notes on diagnosis.

General impression: note 7
- general impression (e.g., movement speed, movement effort, and presence of trunk rotation);
- Is the patient’s preferred position to lean forward when seated or to support their arms?
- Is cyanosis present (color of the face and lips)?
- Is there muscle atrophy or peripheral edema? Is the skin cyanotic, hydrated or trophic?
- Does breathing at rest take visible effort (e.g., nasal flaring or spontaneous pursed-lips breathing)?
- Does the patient speak with a nasal voice or must speech be interrupted frequently?
- Are breath sounds audible?

The position and shape of the thorax: note 8
- Is the thorax in a position normally characteristic of inspiration? note 9
- Are there deformities of the thorax (e.g., pectus excavatum, pectus carinatum, or kyphoscoliosis)?
- Is the shape of the abdominal wall abnormal (e.g., due to obesity or weakened abdominal musculature)?
- Is the shape or position of the lumbar spine, thoracic spine or cervical spine abnormal?
- What is the posture of the shoulder girdle (i.e., shoulder height, protracted position)?

Respiration and respiratory movement: note 10
- Is the respiration rate or depth of breathing abnormal?
- How does the abdominal wall move during inspiration and expiration (i.e., direction and timing)?
- Are the actions of the accessory respiratory muscles abnormal during inspiration and expiration at rest?
- Are the actions of the abdominal muscles abnormal during inspiration and expiration at rest?
- Are there signs of tracheal tug during inspiration?
- Is the infraclavicular or supraclavicular fossa visibly drawn in during inspiration?
- How does the chest move during inspiration and expiration?
- Is the thorax or sternum lifted in an exaggerated way at the beginning of inspiration (i.e., pump-handle movement)?
- How do the lower ribs move during inspiration (e.g., Hoover’s sign or bucket-handle movement)?
- Are any thoracic excursions asymmetrical?

Movement: note 11
- How is the patient’s functional muscle strength during movement from a supine to a sitting position, and from a sitting to a standing position?
- How well do the respiratory muscles function (i.e., strength and endurance)?
- How well does the abdominal musculature function (i.e., strength and endurance)?
- other muscle strength tests (e.g., of the quadriceps muscles);
- How is the patient’s balance?

Other measurements:
- peak expiratory flow, note 6

Measurement of exercise capacity: note 12
- walking test; note 13
- cycle ergometer test;
- oxygen saturation (e.g., using a pulse oximeter); note 14
- dyspnea (e.g., using Borg scale score).15
consideration when drawing up a treatment plan and evaluating treatment. Examples of such factors are increased mucus viscosity, pulmonary function limitations, bronchial obstruction, and poor functioning of respiratory muscles, including the abdominal muscles. For instance, patients with purulent sputum may need to be treated more frequently. Measuring mucus viscosity helps in assessing how difficult it is for patients to cough up sputum.

**Analysis: impaired exercise capacity**

Patients with impaired exercise capacity may be affected by reduced general physical stamina, or by respiratory muscle function or gas exchange disorders, and by feelings of dyspnea. These patients may also experience disabilities in their mobility and on their ability to carry out personal hygiene, housework, occupational, educational or leisure activities, among other things.

Systemic factors that can cause or contribute to impaired exercise capacity include medication use, malnutrition, the presence of other complaints, and a reduced activity level. These may necessitate consultation with or treatment by another specialist.

Local factors that can cause or contribute to impaired exercise capacity include pulmonary function limitations, oxygen transport disorders, and poor respiratory muscle function.

**Treatment plan**

After analysis, a treatment plan can be drawn up for the individual patient. Treatment plans are tools for structuring, monitoring and evaluating treatment. The treatment plan records treatment goals, the procedures to be used in treatment, the treatment strategy, and the patient's and physical therapist's individual responsibilities.

The treatment plan can be divided into two phases. The aim of the first phase is to minimize or eliminate impairments in the musculoskeletal system. For patients with COPD, this means that the load on the muscles controlling breathing should be reduced as much as possible by reducing airway obstruction (i.e., by improving mucus clearance) and by reducing the patient's habitual expansion of the thorax as much as possible from a position that is characteristic of inspiration. Airway collapse must be prevented as far as possible. In the second phase, the aim is to normalize respiratory movement. For patients with COPD, this involves adjusting respiratory movement by optimizing the contribution of the respiratory system's compensatory mechanisms.

In both phases, the patient's load-bearing capacity can be increased. Increasing specific load-bearing capacity partly involves improving the strength and endurance of respiratory muscles. Increasing general load-bearing capacity involves improving physical stamina. The results of the physical therapy diagnostic process determine the different emphases in treatment.

**Therapy**

The therapeutic approach adopted is, in part, based on systematic reviews of the scientific literature. The literature considered for these reviews was collected from the MEDLINE database and from databases of the Dutch Institute of Allied Health Professions (NPI), including a physical therapy index, a rehabilitation index and an occupational therapy index. The collected items were supplemented by scrutinizing reference lists and by receiving additional material from members of the steering group. Studies were only included if they involved randomized clinical trials on (a) the effects of physical therapy on mucus clearance, (b) the effects of exercise training as part of pulmonary rehabilitation in patients with COPD, or (c) the effects of inspiratory muscle training in patients with COPD. Each trial was evaluated on its methodological quality by two independent reviewers using 10 predefined criteria. These criteria were based on generally accepted principles of scientific research. As no more than one point was awarded for each criterion, the highest possible score for any trial was 10. A trial was considered to be of a sufficiently high quality methodologically if it scored more than five points. The conclusions drawn about therapy are based on such high-quality trials.

**Improving mucus clearance**

Physical therapy employs a variety of methods for improving mucus clearance. The following
techniques will be described sequentially: coughing or forced expiration; postural drainage; exercise; chest percussion and mechanical vibration; positive expiratory pressure; the Flutter device; and autogenic drainage. A systematic review of the efficacy of these procedures was carried out. Inclusion criteria were:

- a randomized clinical trial was involved;
- the results concerned only one group of COPD or cystic fibrosis patients;
- the patients underwent a physical therapy intervention aimed at improving mucus clearance; and
- the study outcome measures were relevant to mucus clearance.

### Coughing or forced expiration

#### Mechanism of action

The expiratory airflow rate is high during coughing and forced expiration, thereby assisting mucus transport from peripheral to central airways.\(^5^3,9^5\) Initially during coughing, high intrapulmonary pressure is built up when the glottis is closed; thereafter, the expiratory airflow is high when the glottis opens. Huffing, in contrast, involves forced expiratory airflow with an open glottis, which means that the intrapulmonary pressure is much lower.\(^9^6\) If the expiratory airflow is to be sufficient for transporting mucus, a high flow velocity of, at least, 1 m/s (greater than 2.5 m/s is better) is needed.\(^5^3\) Furthermore, the thickness of the mucus layer is also important. Coughing and huffing are more effective when the mucus layer is thick.\(^5^3\)

During forced expiration and coughing, dynamic compression of the airways takes place. Dynamic compression contributes to the development of very high local airflow velocities in the respiratory tract. The exact location at which the dynamic compression caused by expiratory forces takes place (i.e., the equal pressure point), is dependent on lung elasticity (or lung volume), bronchial obstruction, and bronchial stability.\(^9^7\)

Mucus transport can be facilitated by varying the expiratory force and equal pressure point. If there are signs of airway collapse, however, dynamic compression must be avoided. By using less force and starting from a greater lung volume, compression occurs more centrally and collapse can be, at least partially, prevented. The advantage of forced expiration over coughing is that the lung volume and force can be better controlled.

### Evidence supporting mucus clearance by coughing

Multiple controlled trials have shown that coughing improves mucus transport and, thereby, mucus clearance.\(^9^8\)–\(^1^0^0\) The study by van der Schans et al.\(^1^0^0\) found a difference between chronic bronchitis patients, in whom coughing was effective, and emphysema patients, in whom the efficacy of coughing could not be proven. It was suggested that coughing may be less effective if lung elasticity is compromised.

The literature also revealed that coughing is more effective than postural drainage,\(^9^8,9^9\) but that physical therapy (described as the combination of breathing exercises, chest percussion, vibration, and postural drainage) does not appear to provide any additional benefits to coughing alone.\(^9^9\)

### Evidence supporting mucus clearance by forced expiration (including postural drainage)

Van der Schans et al.\(^1^0^7\) report that forced expiration techniques have positive effects in patients with chronic bronchitis but not in those with emphysema. The reason could be, as noted above, that forced expiration may be less effective when the elasticity of the lungs is compromised. When used in combination with postural drainage, forced expiration is effective in clearing mucus.\(^1^0^1\)–\(^1^0^3\) However, it is not possible to compare the efficacy of forced expiration techniques with that of other procedures on the basis of evidence from the scientific literature because the forms of the different interventions used were highly variable as were the types of intervention being compared.\(^1^0^4,1^0^5\)

### Postural drainage

#### Mechanism of action

In healthy individuals, the effect of gravity on mucus clearance is negligible. This changes, however, when there are alterations in viscoelastic properties, ciliated epithelium function, the quantity of mucus, and the thickness of the periciliary layer.\(^1^0^6\)
Postural drainage techniques use gravity to promote mucus transport. In practice, a particular posture is held for a minimum of 20 minutes, with the relevant bronchus being held vertically. It is essential that the location of the mucus is appropriate for the posture being held. Nine specific postures for draining the large bronchi have been reported.

**Evidence**
The efficacy of postural drainage has not been unequivocally substantiated by literature findings. Rossman et al.\(^99\) reported positive results in patients with cystic fibrosis, whereas Oldenburg et al.\(^98\) showed negative results in patients with bronchitis. The effects of postural drainage have been reported to be inconsistent when it is used in combination with other procedures.\(^108\,109\)

**Exercise**

**Mechanism of action**
Exercise increases expiratory flow velocity, the respiratory minute volume, and sympathetic nervous system activity. These mechanisms increase the ciliary beat frequency, reduce mucus viscosity and, thus, increase mucus transport.\(^110\)

**Evidence**
The only explanatory study on the efficacy of exercise that was of sufficiently high methodological quality showed positive results. Exercise was found to increase bronchial mucus transport.\(^98\) The authors of that study also demonstrated that coughing brings about better mucus clearance than exercise. In a pragmatic study, no differences were found when treatment involving exercise plus forced expiration was compared with other interventions.\(^108\)

**Chest percussion and vibration**

**Mechanism of action**
The physical vibration caused by chest percussion or a mechanical vibrator is transferred to lung tissue and to the respiratory tract. Mucus is loosened by the vibration and cilia activity is stimulated. The mucus composition may also by changed by vibration.\(^111\,112\)

In their reviews, Hansen et al.\(^113\) and Thomas et al.\(^114\) summarized the mechanisms of action of percussion and vibration. The resulting motion can reduce mucus viscosity, stimulate coughing, or, by a resonance effect, reinforce ciliary movement.\(^112\) In addition, Thomas et al.\(^114\) noted improvements in ciliary function and changed mucus composition. A percussion frequency of 25–35 Hz is optimal for mucus transport, but is not achievable manually.\(^115\)

After reviewing the literature, Thomas et al.\(^114\) concluded that the optimal frequency of vibration for improving mucociliary clearance had not been clearly defined but that it is under 60 Hz.

**Evidence supporting mucus clearance by percussion**
The evidence that percussion improves mucus clearance is limited. The literature review did not contain any explanatory studies of sufficiently high methodological quality that proved percussion was effective. Therefore, it is not possible to say whether percussion is more effective than giving no treatment. However, it appears that percussion given in addition to postural drainage offers no benefits over postural drainage alone\(^99\) nor over physical therapy alone (defined as postural drainage plus coughing).\(^116\)

**Evidence supporting mucus clearance by vibration**
The only explanatory study on the efficacy of vibration that was of sufficiently high methodological quality gave negative results. No difference was demonstrated between periods in which vibration was applied and control periods.\(^117\)

**Positive expiratory pressure**

**Mechanism of action**
Before mucus can be cleared from the small airways by coughing or forced expiration, it must be moved to a more central part of the respiratory tract. This can be accomplished by using a positive expiratory pressure mask or mouthpiece to give an expiratory pressure of 10–20 cmH\(_2\)O (centimeters of water). Increasing the functional residual capacity of the lung enables the airways to remain open during expiration.\(^118\) Applying positive expiratory pressure raises the pressure gradient between open and closed alveoli, which reduces resistance in collateral and small airways.\(^119\,120\) This process encourages collateral ventilation, enabling air to collect distally behind the mucus. Mucus is then moved to the central respiratory tract.
Evidence
The application of positive expiratory pressure increases the functional residual capacity of the lung, but this has no effect on mucus clearance. The efficacy of positive expiratory pressure used alone cannot be demonstrated. Several trials have shown that positive expiratory pressure used in combination with forced expiration, or coughing or huffing, does lead to improved mucus clearance. However, these trials do not indicate the magnitude of the contribution of positive expiratory pressure. Because of variability in the nature of the interventions used and in the types of interventions being compared in different studies, it is not possible to say how effective positive expiratory pressure is in comparison to other types of therapy, whether used alone or in combination.

Flutter device
Mechanism of action
The Flutter device uses a combination of positive expiratory pressure and vibration or oscillation applied through the mouth. An expiratory pressure of 5–35 cmH2O is achieved by asking the patient to hold a small ball in the air by blowing. The movement of the ball causes an oscillatory movement at a frequency of 8–26 Hz. In this form of treatment, respiratory tract dilatation caused by increased expiratory pressure and airway vibration are thought to improve mucus transport.

Evidence
The literature review found two trials that examined the effects of the Flutter device used in addition to or instead of physical therapy. Both trials are of low methodological quality and, furthermore, show inconsistent results. The efficacy of the Flutter device cannot, therefore, be substantiated.

Autogenic drainage
Mechanism of action
Autogenic drainage is a method in which patients learn how to promote mucus drainage by themselves. Controlled breathing techniques in which the frequency and depth of breathing are varied are used to achieve the highest possible airflow at different levels of bronchial tree. In other words, a balance is sought between expiratory flow, intrabronchial pressure and bronchial wall stability. The hypothesis is that mucus is mobilized when the patient breathes at a low expiratory flow rate with the lung volume lying between the functional residual capacity and the residual volume. Thereafter, mucus is transported to larger airways by the increase in the tidal volume. Finally, mucus is expectorated by forced expiration, starting with a low lung volume.

Evidence
Miller et al. found no difference in mucus expectoration between patients who used autogenic drainage and those who used physical therapy (i.e., an active cycle of breathing techniques). However, mucus clearance starts more quickly with autogenic drainage.

Effect of physical exercise as part of pulmonary rehabilitation
A total of 18 trials on the efficacy of physical exercise as part of pulmonary rehabilitation in patients with COPD were reviewed. Eleven trials were of sufficiently high methodological quality. Physical exercise was found to have a positive effect on stamina and quality of life in COPD patients. The effects of exercise on walking distance, maximum and submaximal exercise capacity, and quality of life are described sequentially below.

Seven trials studied the effect of exercise as part of pulmonary rehabilitation on walking distance and on maximum exercise capacity. Five of the seven found a positive effect on walking distance and four found a positive effect on maximum exercise capacity.

Exercise used as part of pulmonary rehabilitation has also been shown to have a positive effect on submaximal exercise capacity. However, Reid and Warren and Busch and McClements failed to demonstrate any significant effect on submaximal exercise endurance. In addition, improvements in exercise capacity, or maximum exercise capacity, appeared to occur in patients with severe forms of COPD (i.e., with an FEV1 of between 35–49% of that predicted).

In addition to improving exercise tolerance,
rehabilitation programs can also lead to decreased dyspnea at rest, as assessed by the Chronic Respiratory Disease Questionnaire\textsuperscript{131–133,138} and during exercise.\textsuperscript{129,134,137} However, Busch and McClements\textsuperscript{135} found no resulting difference in the sensation of dyspnea.

Research using different measures on the Chronic Respiratory Disease Questionnaire have given the following results. Of four trials that used the measure of fatigue,\textsuperscript{131–133,138} two showed that exercise as part of pulmonary rehabilitation reduces fatigue.\textsuperscript{132,133} Of four trials that used the measure of emotion from this questionnaire,\textsuperscript{131–133,138} two showed positive results.\textsuperscript{131,138} In addition, all four trials that used the measure of mastery\textsuperscript{131–133,138} showed that exercise training as part of pulmonary rehabilitation had a positive effect. A recent meta-analysis has confirmed the positive effects of pulmonary rehabilitation on exercise capacity, dyspnea and quality of life.\textsuperscript{139}

**Content of rehabilitation programs**

Research by Ries et al.\textsuperscript{134} showed that physical exercise is an essential part of rehabilitation. Providing education alone is not enough to improve exercise capacity. Most rehabilitation programs offer walking, with or without the use of a treadmill, or cycling as methods for improving exercise tolerance. In some trials, climbing stairs\textsuperscript{135,137} or rowing\textsuperscript{130} were used as interventions. Two studies found that training the upper extremities improves the strength and endurance of the relevant muscle groups in patients with COPD.\textsuperscript{140,141} Both trials, however, are of low methodological quality.

**Exercise program duration, frequency and intensity**

Literature studies reveal that the duration of exercise programs used varies from six weeks\textsuperscript{137} to six months.\textsuperscript{131} Positive effects are demonstrable after six weeks or more. The duration of most programs is between 8–12 weeks. The effect of training reaches a plateau within 3–6 months.

The frequency with which patients exercise, including training and practice sessions, ranges from, at least, twice a week\textsuperscript{129,137} to five times a week, or daily.\textsuperscript{134,135,138} Positive effects are achievable with programs that involve twice weekly or more frequent sessions. Recently, it has been demonstrated that patients with COPD can cope with high-intensity exercise.\textsuperscript{134,142} One study indicated that training at a high load produces better results than training at a low load.\textsuperscript{143} This study was conducted on a group of patients with a moderate degree of bronchial obstruction. Maltais et al.\textsuperscript{144} studied the effects of high-intensity exercises on patients with moderate or severe bronchial obstruction. They found that most patients cannot sustain a high load (i.e., 80% of maximum load). However, significant improvements in exercise capacity and a physiological adaptation to exercise occurred.
Follow-up

The importance of follow-up after a rehabilitation program is clearly demonstrated by data from Wijkstra et al.\textsuperscript{42} The researchers found that exercise capacity tended to decrease over time, but that the benefits could be maintained by arranging follow-ups. Ries et al.\textsuperscript{134} followed patients after completion of a rehabilitation program or an educational program. Soon after the programs were completed, there were significant differences between the two groups, with the rehabilitation group showing more positive results. Over the course of time, however, these differences became less marked. In one study, six years after rehabilitation, the survival rate in patients who followed a rehabilitation program was higher than in those who did not, at 67\% compared to 56\%, respectively.\textsuperscript{134} The difference was not statistically significant, however.

Effects of inspiratory muscle training (IMT)

Studies were included in the literature review if they involved randomized clinical trials in which COPD patients underwent respiratory muscle training to improve the strength and endurance of respiratory muscles. If resistance loading was involved, pressure at the mouth had to have been measured. As the guidelines state that training intensity should also be defined, it was later decided to exclude trials in which training intensity was not explicitly described.\textsuperscript{136,145,146} Studies that involved training with normocapnic hyperpnea were excluded\textsuperscript{147–149} because this training regimen is not practically applicable. After applying these selection criteria, 10 trials remained for inclusion in the systematic review. All were of sufficiently high methodological quality.

Effects of inspiratory muscle training on the strength and endurance of inspiratory muscles

In COPD patients, genuine respiratory muscle training leads to a significant increase in respiratory muscle strength compared with placebo respiratory muscle training. Increased endurance and reduced dyspnea have also been reported.\textsuperscript{150} High-resistance respiratory muscle training produces a greater increase in strength and endurance from baseline than low-resistance training.\textsuperscript{151–155} In two of the five trials considered, respiratory muscle strength was different from that in the control group.\textsuperscript{151,153} However, Lisboa et al.,\textsuperscript{155} Harver et al.\textsuperscript{156} and Preusser et al.\textsuperscript{152} found no difference in respiratory muscle strength between the group that trained at a high load and the group that trained at a low load. In addition, Larson et al.\textsuperscript{151} and Preusser et al.\textsuperscript{152} found no difference between the two groups in terms of respiratory muscle endurance.

General effects of inspiratory muscle training

Two of the above five trials examined the effect of respiratory muscle training on dyspnea.\textsuperscript{154,155} Both found that respiratory muscle training reduces dyspnea. Three of the five trials examined the effects of respiratory muscle training on walking distance.\textsuperscript{151,152,155} All three found that walking distance had increased in the group that trained at a high load. In addition, Preusser et al.’s study\textsuperscript{152} found that walking distance in the group that trained at a low load had also increased. Only Larson et al.’s study\textsuperscript{151} found a significant difference between the two groups.

Inspiratory muscle training combined with exercise training

Four trials investigated the effect of adding respiratory muscle training to exercise training by comparing groups that received both with groups that received exercise training alone.\textsuperscript{58,128,130,156} In all trials, the groups that received respiratory muscle training showed increased respiratory muscle strength and endurance compared to baseline. This was not seen in Berry et al.’s study\textsuperscript{128} because no baseline values were given. Two of these four studies showed that respiratory muscle training provided additional gains in terms of respiratory muscle strength and diaphragm fatigability.\textsuperscript{58,156} Weiner et al.\textsuperscript{130} did not make any between group comparisons, and Berry et al.\textsuperscript{128} found no difference between the two groups.

Three of the four studies examined the additional benefits of respiratory muscle training on walking distance and maximum exercise capacity. Two trials showed that respiratory muscle training gave additional benefits,\textsuperscript{58,130} whereas another study found that walking distance was improved by
exercise training but not by respiratory muscle training.\textsuperscript{128}

The only study that investigated the additional effects of respiratory muscle training on dyspnea found no difference between the two training groups.\textsuperscript{128} Moreover, Dekhuijzen et al.\textsuperscript{58} failed to show that respiratory muscle training offered any additional benefit in terms of performing normal daily activities or of emotional functioning.

The results of all these studies are summarized in Table 19.

**Exercise load, duration and frequency**

Preussner et al.\textsuperscript{152} found that a training intensity of 22% PImax resulted in improved respiratory muscle endurance and increased walking distance, but produced no difference in respiratory muscle strength. Larson et al.\textsuperscript{151} found no significant change in respiratory muscle strength or endurance or in walking distance at a training intensity of 15% PImax. Lisboa et al.\textsuperscript{155} found an increase in strength at a training intensity of 10% PImax. In contrast, Heydra et al.\textsuperscript{153} found no increase in strength at a training load of 10% PImax and Larson et al.\textsuperscript{151} found no increase in strength at a training load of 15% PImax. The literature review, therefore, found no consistent evidence about which training intensity results in training effects nor did it show that a higher load leads to better results.

Literature findings on the optimum duration and frequency of training are inconsistent. Different studies report training periods varying from eight weeks\textsuperscript{150,151,154,156} to six months.\textsuperscript{130} However, most trials used a training duration in the range of 8–12 weeks.

The frequency of respiratory muscle training reported in the selected literature varies from four 15-minute sessions a day\textsuperscript{150} to three 15-minute sessions a week.\textsuperscript{130} However, most trials employed a frequency of two 15-minute sessions a day.

Since no consistent conclusions on exercise load, duration and frequency can be derived from the literature review, following the example of the European Respiratory Society, it is recommended that respiratory muscle training takes place five to seven times a week.

Table 19. Summary of the results of randomized clinical trials of sufficiently high methodological quality on the effect of respiratory muscle training, listed in terms of outcome measures.

<table>
<thead>
<tr>
<th>Outcome measure</th>
<th>Explanatory trials</th>
<th>Pragmatic trials: high load versus low load</th>
<th>Pragmatic trials: respiratory muscle training with or without exercise</th>
</tr>
</thead>
<tbody>
<tr>
<td>Respiratory muscle strength*</td>
<td>+(150)</td>
<td>+(151) (+153) –(152) –(154) –(155)</td>
<td>+(58) +(156) +(130) –(128)</td>
</tr>
<tr>
<td>Respiratory muscle endurance*</td>
<td>+(150)</td>
<td>+(153) –(151) –(152) –(128)</td>
<td>+(58) +(156) +(130) –(128)</td>
</tr>
<tr>
<td>Dyspnea</td>
<td>+(150)</td>
<td>+(151) –(155) –(152) –(155)</td>
<td>+(154) +(155)</td>
</tr>
<tr>
<td>Walking distance</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Exercise capacity**</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Performance of normal daily activities and emotional functioning</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

* includes strength or diaphragm fatigability;  
** (sub)maximum exercise capacity (including maximum oxygen volume consumption rate, VO\textsubscript{2}max); + = there is a significant difference between the intervention and control groups in favor of the intervention group; – = there is no significant difference between the two groups.

Note: The study of respiratory muscle strength and endurance carried out by Weiner et al.\textsuperscript{130} involved an between group comparison within the experimental group.
days a week for two 15-minute sessions per day for a
minimal training duration of eight weeks. The
training load should be between 30–40% $P_{\text{Imax}}$.157

Training method
Different training methods place different loads on
the respiratory muscles. It is possible to customize the
method for each individual on the basis of the
magnitude of pressure or flow, or a combination of
the two.158 If resistance loading is used, pressure at
the mouth will need to be monitored in order to be
certain that a specific load is being applied. A change
in breathing strategy, in particular one involving the
use of slow deep breathing, can reduce the actual load
on the respiratory muscles.159 By consensus, the
steering group recommends that the ratio of
inspiration time to expiration time should be
maintained at 3:5.

The threshold training method has been shown to be
a reliable and reproducible method of loading the
respiratory muscles in patients with COPD.160

Decreasing dyspnea
Active expiration
When respiratory demand increases in healthy
people, the abdominal muscles automatically begin
to take up some of the load.161 In patients with COPD,
the abdominal muscles contribute to breathing even
at rest. This almost exclusively involves the transverse
abdominal muscle.162 Tensing the abdominal muscles
during expiration improves the position of the
diaphragm, enabling it to deliver more force.
Reybrouck et al.163 compared the effects of active
expiration using myofeedback from the abdominal
muscles with active expiration without such
feedback. The patient group who used myofeedback
showed a significantly greater decrease in functional
residual capacity and an increase in $P_{\text{Imax}}$.157

Reducing the respiratory rate
Breathing at a low frequency at rest results in
improved alveolar ventilation and better arterial
blood gas concentrations. However, during exercise,
low-frequency breathing does not significantly
improve gas exchange and the respiratory minute
volume is significantly reduced.164

Body posture
Adopting a particular body posture can lengthen the
diaphragm, enabling it to provide more force and to
contribute more to respiration. The study carried out
by Sharp et al.165 supports this observation. They
found that, in patients who benefit from leaning
forward, electromyographic activity in the inspiratory
accessory muscles increases significantly when they
stand up straight or sit. In contrast, therefore, leaning
forward reduces electromyographic activity in the
accessory muscles. The trials conducted by Druz and
Sharp166 and O’Neill and McCarthy167 point to the
same conclusion: that leaning forward improves the
function of the diaphragm.

Pursed-lips breathing
Pursed-lips breathing involves exhaling steadily
through slightly pursed lips. This action counteracts
dynamic compression of the respiratory tract such
that functional residual capacity decreases and
inspiratory capacity increases. In addition, pursed-lips
breathing slows the respiratory rate and increases
tidal volume.79,168,169 Not every patient benefits from
this technique. The effects of pursed-lips breathing
(i.e., decreased respiratory rate and increased tidal
volume) are more significant in patients who benefit
from pursed-lips breathing.79 Moreover, pursed-lips
breathing at rest improves blood gas
concentrations.79,168,169 These effects have not been
observed during exercise.79 Pursed-lips breathing at
rest can reduce dyspnea. The mechanism of action is
not yet clear.

Diaphragmatic breathing
Diaphragmatic breathing is wrongly thought to be an
effective way of breathing. Gosselink et al.170 found
that diaphragmatic breathing in severe COPD patients
results in poorer coordination of respiratory
movement and decreased mechanical efficiency of
the diaphragm. There is also a tendency for dyspnea
to increase.

Habituation
The mechanisms causing habituation are not yet
understood. Various trials have shown that exercise
can reduce dyspnea but physiological training does
not appear to have an effect.171,172 Rosser and Guz173
have suggested that psychological factors may
explain the reduction in dyspnea. Another study of the importance of psychological factors showed that dyspnea can be reduced if training occurs in a familiar environment\textsuperscript{174} and if distracting stimuli such as music are present during exercise.\textsuperscript{175} These effects may occur because cognitive and contextual factors play a role in dyspnea.

Another mechanism could be desensitization. In desensitization, psychological or physiological factors may lead to reduced awareness of dyspneic stimuli or to reduced sensitivity of peripheral or central receptors, or both.

**Improving compliance with therapy**

Kanters\textsuperscript{176} carried out a literature review of the efficacy of patient education. He concluded that patient education does result in greater compliance with therapy in short-term disorders, but that ensuring compliance with therapy in chronic disorders requires continuous attention: “Patient education cannot change the somatic basis of chronic bronchitis or pulmonary emphysema at all. What does occur is that the patient gains a greater grasp of and copes more wisely with his disease”.\textsuperscript{176}

Van der Burgt and Verhulst\textsuperscript{177} carried out an overview of all the education models used in health education and translated them into a model of patient education for use in allied health care practice. In so doing, they integrated the Attitude, Social Influence and Personal Efficacy determinant model with Hoenen et al.’s step-by-step approach to providing information.\textsuperscript{178} The Attitude, Social Influence and Personal Efficacy determinant model is based upon the assumption that willingness to change behavior is determined by a combination of the patient’s attitude (how the individual perceives behavioral change), social influences (how others see behavioral change) and the patient’s perception of his own efficacy, his self-efficacy (whether the patient thinks it will work or not). The step-by-step approach to providing information proposed by Hoenen et al.\textsuperscript{178} distinguishes between the stages of openness, understanding, willingness and doing. With allied health care practice in mind, van der Burgt and Verhulst added two extra phases: ability and persistence. To do justice to the patient’s individuality, another phase, designated ‘the person’, was added to the model, as described below. Van der Burgt and Verhulst\textsuperscript{177} regard patient information as a process in which behavioral modification is the final step. This final step cannot be taken until the previous stages are complete. The six stages must be completed sequentially. See Table 20.

In addition, during all stages of the educational process, it is important to take individual characteristics of the patient into account, such as his or her:

- locus of control; To what extent does the patient believe that he or she can influence the course of his or her life?
- attribution; What factors does the patient regard as influencing the course of his or her life?
- coping styles; How does the patient react to significant events in his or her life?
- emotional state; Is the patient unable to accept new information because of his or her emotional state? The answer to this question may also determine how the patient handles his or her disease and its treatment.

Knibbe and Wams\textsuperscript{179} describe a system for increasing compliance with therapy. It differentiates between short-term and long-term compliance. To achieve long-term therapeutic compliance, a great deal of attention must be paid to evaluating the advantages and disadvantages of therapy and to the individual’s sense of their own effectiveness. The patient’s perception of the advantages and disadvantages of therapy can be influenced by logical argument. The patient’s sense of individual effectiveness can be increased by helping him or her to feel that he or she is capable of performing the behavior, i.e., that he or she has mastery over the situation.

**Education plan**

The physical therapy treatment plan must include an education plan, in which subgoals are formulated for each stage. The education plan can be seen as part of a methodical approach to patient management. It can begin during history-taking with an analysis of the patient’s need for information: What does the patient know about his or her disorder and about the medications he or she will use? How efficient is the
method used for administering the medication and does the patient know how it can be improved? What are the patient’s and his or her partner’s expectations of treatment? At every stage, it is important to pay attention to any problems the patient is experiencing. By adopting this approach, information about the possible causes of any problems in complying with therapy can be obtained.

Dekkers subdivides patient education into four categories: information, instruction, education and guidance. This classification is hierarchical in that activities in the category of information require the least intervention whereas those in the category of guidance require the most.

- **Information:** providing the patient with factual information about the disease, its treatment, and medical care.
- **Instruction:** providing specific guidelines or recommendations for patients to enable them to assist the treatment process.
- **Education:** providing an explanation of the disease and its treatment in such a way that the patient understands the background to and consequences of the condition and appreciates what he or she can do to keep the disease under control. Self-care skills should be practiced, if necessary.
- **Guidance:** supporting the patient emotionally so that he or she can cope with and come to terms with the disease and its effects to the greatest extent possible.

### Table 20. The six stages in the process of patient education.

<table>
<thead>
<tr>
<th>Stage</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. <em>Openness</em></td>
<td>In patient education, the physical therapist must take into account the patient’s perceptions, expectations, questions and concerns. Significant questions are: What is the patient most concerned about? What preoccupations prevent the patient from being open to information about behavioral modification?</td>
</tr>
<tr>
<td>2. <em>Understanding</em></td>
<td>Information must be presented in such a way that the patient understands it and can remember it. The important points here are: not to present too much information at one time, to decide what information must be presented first and what can be given later, and to repeat the message (if necessary, in another way) and to explain it using educational aids, such as leaflets or videos. The physical therapist should check whether the patient has actually understood the information.</td>
</tr>
<tr>
<td>3. <em>Willingness</em></td>
<td>The physical therapist notes the factors that make the patient unwilling to act. The important questions here are: In what way does the patient benefit from exercise? Is the patient encouraged or discouraged by people in his or her close environment? Does the patient feel that he or she can influence the situation? The physical therapist provides support and information on alternative courses of action. Achievable goals are set.</td>
</tr>
<tr>
<td>4. <em>Ability</em></td>
<td>The patient must be able to carry out the desired behavior. The essential functions and skills must be practiced. It is important to find out what practical problems the patient expects and to explore with the patient how these problems can be solved.</td>
</tr>
<tr>
<td>5. <em>Doing</em></td>
<td>This stage includes implementation of the new behavior. The physical therapist makes clear, specific, attainable agreements with the patient and sets specific goals. If possible, positive feedback is given.</td>
</tr>
<tr>
<td>6. <em>Persistence</em></td>
<td>The patient should continue to carry out the behavior after the end of treatment. During treatment, the physical therapist must find out from patients whether they think they will succeed in continuing. It is important to find out what discourages and what encourages the patient, and what the short-term and long-term benefits are. What helps the patient to get back on track after a relapse?</td>
</tr>
</tbody>
</table>
In practice, these four categories overlap. However, it is important to distinguish between them so that different goals can be targeted during patient education. The practical consequences of the different categories of activity are quite different, as are the time and educational aids and skills required. Activities under the category of education involve a more didactic style and require more teaching aids than disseminating information. Signs of denial or non-acceptance indicate that the patient’s greatest need is for emotional support. If this is the case, the referring physician should be consulted.

The following subjects must be covered in patient education:134,181

• medical aspects of the disorder, including the physiology and pathophysiology of respiration;  
• COPD and medication use, including oxygen therapy;  
• medication techniques and personal hygiene;  
• healthy eating;  
• physical therapy and breathing exercises;  
• personal advice on movement; and  
• ways to improve social participation.

In a study of the role of patient education in physical therapy, Sluis182 concluded that it is a vital component of treatment: information was provided in 97% of therapy sessions. On the basis of this study, Sluis made a number of observations:

• little information was given on matters of general health, health education, and psychosocial support, even though patients needed it. More clarity is needed in those subjects that physical therapists have to communicate.  
• most of the information was given in the first two sessions. The patient education plan should be designed so that the information can be provided evenly over the course of treatment. It is possible for the therapist to work systematically and to pay attention to all aspects of education without patients having to receive too much information at one time;  
• two factors that significantly influence compliance were the obstacles patients experienced and a lack of positive feedback. To help counteract these, the exercises and advice given should be tailored to the individual patient’s situation. The physical therapist must also regularly pay attention to the problems experienced by patients in performing exercises and in implementing behavioral modification. The physical therapist should also make greater use of positive feedback.

In the Netherlands, the (Dutch) National Center for Medical Information and Health Education (GVO), the Dutch Asthma Foundation, and COPD nurses can offer support during the educational process.

Completion of the treatment
At some point during treatment and, necessarily, at the end of treatment, the referring physician should be informed about the treatment carried out and its results.183 Interdisciplinary communication is an essential part of effective rehabilitation.

After-care
After treatment has been completed, patients must adopt an active approach to maintain the gains they have achieved. After-care usually involves regular exercise. In the Netherlands, the Dutch Asthma Foundation (Nederlands Asthma Fonds) organizes athletic groups for individuals with COPD. These involve participation in specially adapted group sports and games. The patient’s health status determines whether participation in an athletic group is possible. The exclusion criteria are an FEV₁ of less than 1000 ml (or less than 45% of that predicted) or arterial hypoxemia during exercise. In the Netherlands, alternative sporting activities are organized in several cities for patients who cannot participate in regular COPD athletic groups. Information about these activities can be obtained from the Dutch Asthma Foundation.

The legal significance towards the guidelines
Guidelines are no statutory regulations, but they give insights and recommendations, based on the results of scientific research, which health care workers must fulfill to attain quality care. Since the recommendations are mainly based on the ‘average patient’, the health care workers have to use their professional autonomy to deviate from the guidelines if this the patient’s situation requires this. Whenever there is a deviation from the guidelines, this has to be...
augmented and documented.1,2 The responsibility for the interventions remains with the individual physical therapist.

Revisions
The KNGF-guidelines are the first development in clinical questions pertaining to diagnostics, treatment and prevention for patients with chronic bronchitis and emphysema. Developments that can improve the physical therapeutic care of this group of patients, can change the current insights written in the guidelines. In the method for developing and implementing guidelines is indicated that all guidelines will be revised after three to five years maximum after the original publication.1,2 This means that the KNGF, together with the working group, will decide not later than in the year 2003 if these guidelines are still accurate. If necessary a new working group will be installed to revise the guidelines. The validity of the guidelines expires if new developments give reasons to start a reversionary process.

Before the reversionary process, also the Method for Guideline Development and Implementation will be updated based on new insights and cooperation agreements made between the several guideline developers in The Netherlands. The consensus products of the Evidence Based Guideline Meeting (EBRO platform), which are developed under the auspices of the CBO, will be included in the updated method. The uniform and transparent methods for the determination of the amount of evidence and the derived recommendations for practice are important improvements.

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Notes on diagnosis

1. One or more questionnaires may be used to assess quality of life. The Chronic Respiratory Disease Questionnaire (CRDQ), the St George’s Respiratory Questionnaire (SGRQ) and the Medical Psychological Questionnaire for Lung Diseases (MPQL)\textsuperscript{186} are useful for the physical therapist and have been tested for reliability and validity. The MPQL is no longer available and will, therefore, not be discussed further here. The CRDQ covers the effects of dyspnea on normal daily activities, emotion, fatigue, and symptom control.\textsuperscript{40,185,186} The SGRQ evaluates symptoms, activities limited by dyspnea, and the impact of COPD on other factors, such as work, symptom control, and normal daily activities.\textsuperscript{187,188} More information is given in Chapter 7 of the Dutch project report.\textsuperscript{189} These questionnaires are primarily intended to enable the therapist to gain an impression of the patient’s quality of life and to describe treatment. They are not intended to determine the effects of treatment in individual patients because they were developed to study groups and it is not clear how valid they are for individuals. The SGRQ is freely available for use (see discussion of measuring instruments in the guidelines). Answer sheets are required to use the CRDQ (these can be ordered through the physical therapy departmental office at the VU Hospital in Amsterdam, the Netherlands).

2. As far as possible, patients themselves should determine what information they need. As a result, the medical practitioner will be better able to understand the patient’s life, the patient will find the information more useful, and he or she will be encouraged to share responsibility for communication with the medical practitioner.\textsuperscript{190} The treatment team must agree on who is responsible for providing what information to the patient.

3. Coughing or huffing may be unproductive because there is: an inadequate expiratory force due to muscle weakness, pain or abdominal wall insufficiency; insufficient inspiratory breathing volume; or tracheobronchial collapse.\textsuperscript{14}

4. This provides information on where mucus retention can occur.

5. This provides information on where sputum is being retained.

6. The peak expiratory flow is the maximum airflow rate during forced expiration. The patient can use peak flow measurements to check airway obstruction at home. The margin of error in these measurement is 10–20%. The European Respiratory Society recommends taking the highest of the first three technically good expirations.\textsuperscript{191} This technique is not suitable for measuring the degree of obstruction in COPD patients.

7. Provides information about the severity of the disorder and the patient’s disease stage.

8. Provides information about load-bearing capacity and about the disorders that have developed because of adaptation to pulmonary obstruction.

9. When the thorax is in a position characteristic of inspiration, the anteroposterior and lateral diameters of the thorax are greater, the epigastric angle is obtuse, the ribs and clavicle are more horizontal, and the distance between the cricoid and the manubrium sterni is smaller.\textsuperscript{14}

10. Provides information on the load-bearing capacity and about the disorders that have developed because of adaptation to pulmonary obstruction. Respiration or respiratory movement may adapt before changes in the position and shape of the thorax are visible.

11. Testing movement provides information about load-bearing capacity and muscle function impairments in the pulmonary patient. PImax should be measured to assess the strength of the respiratory muscles. Normal values are given in terms of centimeters of water (cmH\textsubscript{2}O). by Rochester and Arora:\textsuperscript{192} for women between the ages of 19–49 years, the normal value is -91 cmH\textsubscript{2}O; for women between the ages 50–69, -77 cmH\textsubscript{2}O; for women aged 70 years and over, -66 cmH\textsubscript{2}O; for men aged 19–49 years, -127 cmH\textsubscript{2}O; for men aged 50–69, -112 cmH\textsubscript{2}O; and for men aged 70 years and over, -76 cmH\textsubscript{2}O. If PImax is lower than 70% of normal, respiratory muscle
strength is reduced. A handheld dynamometer can be used to assess the strength of other peripheral muscles.\textsuperscript{193} For normal values and further information, refer to Chapter 7 of the Dutch project report.\textsuperscript{189}

12. Provides information on the patient’s level of stamina.

13. The walking test is a reliable measure of stamina. Although the 12-minute test has somewhat higher sensitivity, reliability and discriminatory power,\textsuperscript{194} the 6-minute test is recommended by the steering group because it is quicker and, therefore, more practical. The ‘shuttle’ walking test is another option. More information is given in the Dutch project report.\textsuperscript{189}

14. Pulse oximeters provide a non-invasive means of estimating blood oxygen saturation. The pulse oximeter used should be accurate during exercise and sensitive to changes in oxygen saturation up to a level of at least 90\%. The Hewlett-Packard and the Biox II pulse oximeters meet these standards.\textsuperscript{195}

15. The Borg scale is preferred by the steering group because it has higher reliability and stability and because its results correlate better with respiration.\textsuperscript{196} The Borg scale is also simpler to use and easier to standardize. Visual analogue scales are good alternatives.\textsuperscript{196}
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Abbreviations and glossary of terms

CNSLD  chronic non-specific lung disease
COPD  chronic obstructive pulmonary disease
FEV₁  forced expiratory volume in one second
PImax  maximum inspiratory pressure at the mouth
TLco  transfer coefficient, expressing the diffusion capacity of the lung per unit of lung volume (also known as DLco and Kco)

activity  execution of a task or action by an individual
disability  difficulties an individual may have in executing activities. Activities can be limited in type, duration and quality.
huffing  forced exhalation with an open glottis
coughing  forced exhalation with a closed glottis
disorder  abnormality in a body structure, or loss of or abnormality in a physiological or psychological function
incidence of CNSLD  number of new CNSLD patients in a given period of time
incremental exercise test  maximum exercise test carried out under the supervision of a pulmonary physician, during which various parameters are measured
participation  involvement in a life situation, in the context of disorders, activities, health condition and environmental factors. Participation can be restricted in type, duration and quality
prevalence of CNSLD  number of CNSLD patients at a given point in time
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