Improving Exercise Tolerance and Quality of Life in Patients With Chronic Obstructive Pulmonary Disease

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Chronic obstructive pulmonary disease (COPD) is the fourth leading cause of mortality in the United States. Its symptoms, comorbidities, and sequelae also result in high morbidity and healthcare costs. The impact of progressive dyspnea, fatigue, exercise intolerance, and recurrent exacerbations in patients with COPD can be devastating to their quality of life. Unaddressed, these symptoms often result in depression and social isolation, causing further decline in exercise tolerance and functional performance. Assessing the physiologic, pharmacologic, and psychosocial factors that influence these elements can be challenging in the primary care setting. The present article describes a practical approach to assess functional performance and outlines pharmacologic and nonpharmacologic strategies—particularly self-management education and pulmonary rehabilitation—to improve quality of life indicators.

The Global Initiative for Chronic Obstructive Lung Disease (GOLD)[1] defines chronic obstructive pulmonary disease (COPD) as follows:

> [A] preventable and treatable disease with some significant extrapulmonary effects that may contribute to the severity in individual patients. Its pulmonary component is characterized by airflow limitation that is not fully reversible. The airflow limitation is usually progressive and associated with an abnormal inflammatory response of the lung to noxious particles or gases.

In addition, the joint American Thoracic Society/European Respiratory Society task force[2] characterized COPD "by the presence of airflow obstruction due to chronic bronchitis or emphysema." They also described COPD-related airflow obstruction as "generally progressive," possibly with airway hyperreactivity. However, such a condition may be partially reversible.[2]

The potential to partially reverse COPD brings hope to patients with this debilitating condition. In 2004, COPD accounted for nearly 124,000 deaths, ranking it the fourth leading cause of mortality in the United States.[3] In the same year, 12.6 million noninstitutionalized adults were diagnosed as having chronic bronchitis or emphysema.[4] In addition, approximately 14 million individuals in the United States have COPD but remain undiagnosed.[5]

According to current data, morbidity caused by COPD increases with age and is greater in men than in women—though morbidity and mortality are increasing in women at a faster rate than in men.[5] Furthermore, contrary to the common perception that COPD is a disease of elderly patients, data from the third National Health and Nutrition Examination Survey (NHANES III) found that approximately 70% of patients with COPD are younger than 65 years.[5-7] Therefore, unless otherwise indicated, the discussion provided in the following pages pertains to patients of any age who have been diagnosed as having COPD.

Impact of COPD

Dyspnea and exercise intolerance are the two most common complaints from patients with COPD, who also have to cope with exacerbations and remissions. Exercise, activities of daily living (ADLs), and health-related quality of life (HRQL), which can be severely affected by such exacerbations, are interrelated and substantially impact the lives of these patients. Depression, anxiety, and related emotional problems are often the sequelae of this impact. Physicians must be aware of the various adverse effects related to COPD to better assess and treat affected patients.

Exercise

Most healthy adults equate exercise with strenuous workouts leading to increased physical fitness. However, the suggestion of an exercise program to patients with COPD is usually met with incredulity or scorn. For most individuals with moderate to severe COPD, even basic daily activities can be strenuous and daunting. Patients state they are too fatigued for even mild exercise and that any exercise makes them too short of breath and very uncomfortable.

Individuals with COPD typically have a slow, insidious decline in exercise ability. Patients consistently report lower levels of functional performance for ambulation, sleep and rest, and home management as well as recreation and other activities.[8-10] Patients with moderate or severe COPD report at least 15% impairment in each of these categories, while oxygen-dependent patients report 25% to 40% impairment.[11]

These findings suggest that afflicted patients have lower levels of physical activity than healthy patients.[12] One study[13] showed that approximately 30% of patients with moderate or severe COPD are effectively housebound when COPD is stable. This number rises to nearly half of patients during an exacerbation.[13] Pitta et al[12] documented that elderly patients with COPD spent substantially more time in a supine position or sitting and less time walking or standing compared to healthy elderly patients (*Figure 1*). This difference has major implications for overall health and fitness levels in this population and places individuals with COPD at risk for multiple comorbidities.

Exercise intolerance in patients with COPD results from a complex interaction between symptoms, impairment to ventilatory and respiratory mechanics impairment, gas exchange limitations, and peripheral muscle fatigue. Patients commonly cite dyspnea and leg fatigue as the main reasons for reducing or stopping exercise.[14] Intolerance to exercise is closely linked to impairment and disability and is a stronger predictor of poor quality of life and survival than either spirometry or oxygenation[15] and thus contributes to progressively limited ADLs.

In COPD, resting residual volume is increased and inspiratory capacity (IC) ("room to breathe") is decreased as a result of air trapping and hyperinflation. Patients with COPD have a reduced ability to increase tidal volume to meet ventilatory demands during physical activity (*Figure 2*). Airflow obstruc-tion associated with COPD also leads to air trapping and hyperinflation that become more profound during exercise as the respiratory rates increase. This effect may be referred to as *dynamic hyperinflation*. In addition, the IC decreases further with activity and may correlate more strongly to dyspnea than measures of airflow such as forced expiratory volume in 1 second (FEV_1). The intensity of exertional dyspnea correlates to the degree of dynamic hyperinflation experienced by COPD patients.[16]

Exercise intolerance, HRQL, and even survival are substantially affected by acute exacerbations.[17-21] Cote and colleagues[20] explored the impact of acute exacerbations on the following outcomes comprising the BODE Index: Body mass index (BMI), Obstruction (FEV_1), Dyspnea (using a modified Medical Research Council dyspnea scale), and Exercise capacity (6-minute walk distance). Measurements were taken at baseline, during the initial exacerbation, and at 6, 12, and 24 months after the first exacerbation. All exacerbations were documented for 2 years.

Of the 205 patients with COPD (mean [SD], FEV_1 43% [15%] predicted), 130 patients (63%) had a total of 352 exacerbations—48 patients had one episode and 82 patients had two or more.[20] In addition, 50 patients required hospitalization. The BODE Index score worsened by 1.38 points during the exacerbation and remained 0.8 and 1.1 points above baseline at 1 and 2 years, respectively. At 2 years, few changes were found in those who had no exacerbations.

Symptoms (particularly dyspnea and fatigue), activity limitation, and HRQL are affected more during and for several weeks after acute exacerbations.[21] The negative impact of acute exacerbations on exercise ability and progression of disease severity are clear. Therefore, physicians must consider the influence of such factors as baseline respiratory function, individual susceptibility to muscle fatigue, exercise modality, and bronchodilation status when assessing exercise tolerance in patients with COPD. Interventions should be aimed at decreasing symptoms and improving exercise ability.

Activities of Daily Living
The combination of symptoms and the life changes resulting from an inability to exercise affect patients' ADLs. Basic ADLs include ambulating;
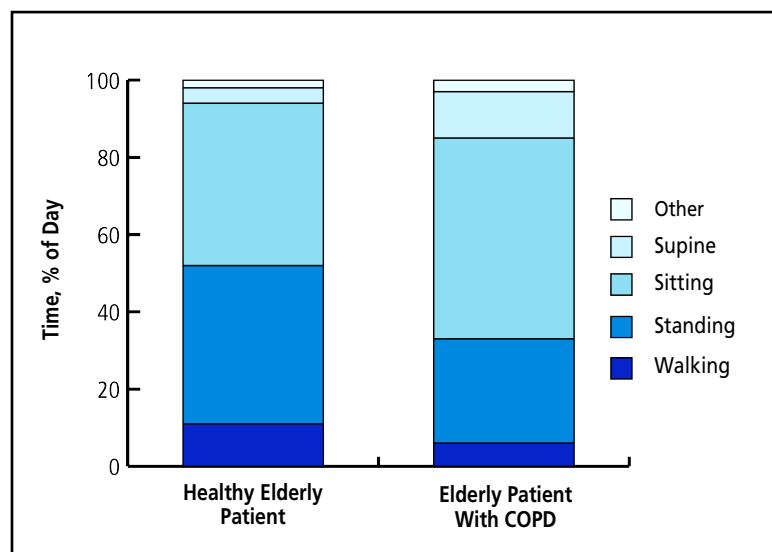

Figure 1. *Daily activities of a healthy elderly patient compared with those of an elderly patient with chronic obstructive pulmonary disease (COPD). Adapted from Pitta et al, Am J Respir Crit Care Med. 2005;171:972-977.[12]*
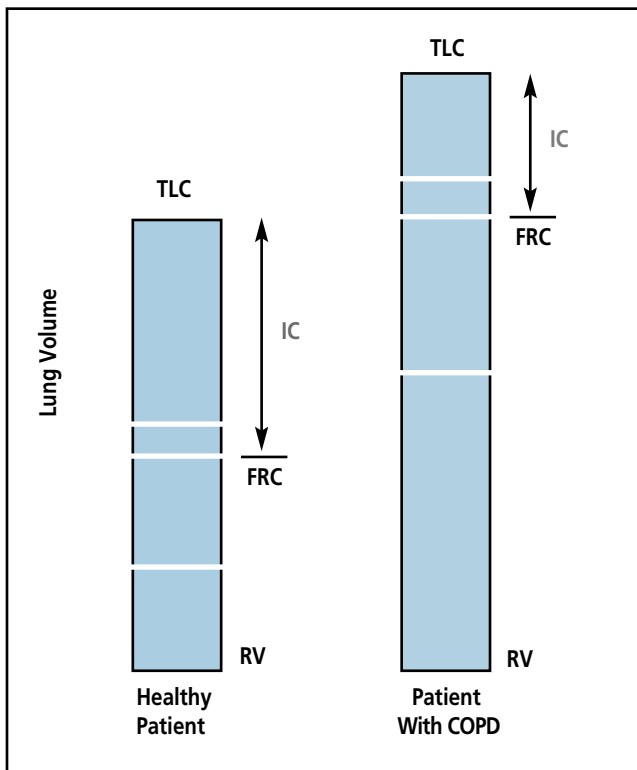
Figure 2. *Lung volume in a healthy patient compared to that of a patient with chronic obstructive pulmonary disease (COPD).* **Abbreviations:** *FRC, functional residual capacity; IC, inspiratory capacity; RV, residual volume; TLC, total lung capacity.*

eating; bathing, dressing, and grooming; and unassisted toilet use. Instrumental ADLs involve higher functioning, such as home maintenance, shopping for clothing and food, preparing meals, traveling alone via car or public transportation, and managing finances.

The elimination or alteration of ADLs depends on the necessity or desirability of the activity, the intensity of symptoms, tolerance level of symptoms, and changes in health expectations. Leisure activities are often the first to be eliminated, as they generally require greater effort and are not critical to daily life. In addition, most patients with COPD have clinically significant comorbid conditions (eg, cachexia, heart disease, peripheral vascular disease) and may have adverse effects from medication. These conditions add to declining functional status in patients with COPD but are often overlooked during pulmonary assessment. Elimination of these activities may be the primary determinant of impaired quality of life.

Quality of Life

The term *quality of life* has been defined as a "holistic, self-determined evaluation of satisfaction with issues important to

the person."[22] It is affected by many factors including family relationships, financial security, job satisfaction, social interactions, spiritual fulfillment, and, importantly, health status. Health-related quality of life specifically focuses on those areas affected by health and quantifies disease impact on ADLs and the individual's sense of well-being.[22] Quality of life has a direct relationship to ADLs in all people. For example, depression and social isolation may be present secondary to a person's inability to complete even the simplest of activities.[23]

Because of the complex relationship between physiologic impairment and functional status limitation, it is important to note that no direct relationship has been established between changes in exercise performance and HRQL.[24] For example, improvement in 12-minute walking distance was correlated to improvement in four dimensions of quality of life,[24] as measured by Guyatt's Chronic Respiratory Disease Questionnaire.[25]

The mean (SD) increase of 557 (300) feet in the 12-minute walking distance represented a statistically significant improvement over baseline (37.6% [42.5%]; $P<.001$). The degree of improvement in the quality of life score (all four dimensions) was similar, with an absolute (SD) score increase of 6.7 (6.0) or a 35.9% increase over baseline ($P<.001$). In a correlation coefficient matrix, no statistically significant association was seen between the change in 12-minute walking distance and change in the quality of life score or any of its four dimensions. Therefore, improvements in HRQL most likely stem from indirect effects on improved self-efficacy (eg, patient confidence in disease management), coping strategies, and task-associated dyspnea.[26]

Depression and Anxiety

In patients with severe COPD, anxiety and fear of dyspnea can become a source of distress.[27] In fact, the most commonly reported emotional consequence associated with COPD is depression.[28,29] Reported prevalence of depression ranges from 7% to 42%[28] with levels 75% higher among patients with severe oxygen-dependent disease.[30] The reported prevalence of anxiety among patients with COPD is also considerable, with 33% of patients having moderate to severe anxiety and 41% having panic disorder.[31]

Depression and anxiety have major consequences in that they affect patient functioning at multiple levels. Fatigue, lethargy, and mental confusion, as well as difficulty concentrating and following instructions, often accompany COPD-related depression and anxiety, affecting adherence to the medical treatment plans and preventing participation in exercise.[32]

Depression is difficult to recognize in routine clinical practice because symptoms are frequently overlooked or attributed to COPD. It is also undertreated because it is seen as an inherent part of COPD. When depression and anxiety are addressed and the patient is treated, many of these prob-

lems can be minimized. If not addressed, the patient remains largely inactive and HRQL is adversely affected.

Emotional Sequelae

Chronic obstructive pulmonary disease is often perceived by patients as a self-inflicted and irreversible condition, leading them to feelings of despair and futility. Loss of income and the concerns and feelings of the patient's spouse (eg, grief, anger, resentment, abandonment, pity) may result in role reversal. A new sense of impending mortality may also be among the weighty psychosocial stressors.[33]

Irritability, frustration, aggressive behavior, guilt, and hopelessness are other commonly observed sequelae of COPD.[11,34] Sexual dysfunction is well documented in both sexes and is closely linked with cardiopulmonary dysfunction, psychogenic impotence, and hypoxemia.[11] At the same time, cognitive decline secondary to aging and hypoxemia adds to these challenges.

These emotional and neuropsychological responses to COPD contribute significantly to morbidity. Activity avoidance because of depression, anxiety, dyspnea, and fatigue lead to muscle weakness and deconditioning, which, in turn, make future attempts at activity even more overwhelming and unlikely (*Figure 3*). This spiral of worsening dyspnea and inactivity often results in feelings of anxiety, uselessness, and lack of control, further contributing to inactivity and overall disability.

Assessment and Diagnosis

Much has been written about the use of lung capacity tests in the assessment and diagnosis of COPD.[35,36] Exercise performance and functional assessment are also invaluable tools in this setting.

A number of factors are used to determine exercise performance. Forced expiratory volume in 1 second is a simple measurement of ventilatory capacity and is a primary physiologic determinant. However, two patients with similar numbers in objective pulmonary function can have large differences in exercise ability. In addition, individual dyspnea perception, the effectiveness of pharmacologic therapy, self-efficacy, and psychosocial strengths—personality traits such as optimism that help individuals cope more efficiently with problems[34]—impact this difference.

Several disease-specific questionnaires have been developed to measure the difficulties with or symptoms experienced during ADLs.[37-41] Subscores of disease-specific HRQL measures such as the dyspnea and fatigue domains of the Chronic Respiratory Disease Questionnaire[25] and the symptoms, activity, and impact subscores of the St George's Respiratory Questionnaire[42] may also provide markers of functional performance.

Environmental and personal contextual factors such as cul-

ture, sex, and age in addition to the disease process affect functional performance. Failure to consider the influence of these factors may distort the clinical estimate of disease impact on functional performance. Measures of functional capacity (eg, tests of strength, endurance, coordination, reaction time) are widely used in pulmonary rehabilitation programs to measure patient progress.

The measurement of functional performance, however, is more challenging because physicians must rely on self-reported measures. Commonly used measures in clinical research include the Sickness Impact Profile,[43] Medical Outcomes Study SF-36,[44] and the Functional Performance Inventory.[41] Currently, there is no consensus about how best to measure functional performance.

For a simple assessment of ADLs, clinicians can ask the patient or caretaker simple questions related to basic tasks of living, as provided in *Figure 4*. Likewise, instrumental ADLs may be assessed by further questioning to evaluate the patient's "higher" capabilities. Patients with chronic but stable illnesses who remain productive are usually able to perform all or most of the activities listed in *Figure 4* and are also able to engage in many of the following "productive" activities:

- ☐ employment
- ☐ gardening
- ☐ going to movies
- ☐ recreational travel
- ☐ social activities
- ☐ sporting or recreational activities
- ☐ volunteer work

Activities of daily living and quality of life may be seen as a continuum in COPD. The primary care physician should be able to ascertain an approximate level of severity by assessing the patient's ability to perform basic and instrumental ADLs as well as productive activities. In early COPD, with only mild dyspnea on exertion, the patient should be able to participate in most productive activities. In "stable" COPD, with moderate dyspnea on exertion, patients should be able to accomplish at least most of the instrumental ADLs. Finally, in severe COPD, patients may be able to complete only the most basic ADLs or they may need assistance with them.[45]

Primary care physicians should query patients to discover clues for the early diagnosis of COPD and to determine disease progression. Perhaps one of the most important questions is: "Have you given up any activities as a result of shortness of breath or fatigue?" Spirometry readings should be ordered whenever the disease is suspected based on symptoms, risk factors, or both.

In addition, several tools are available for anxiety and depression screening, such as the Hospital Anxiety and Depres-
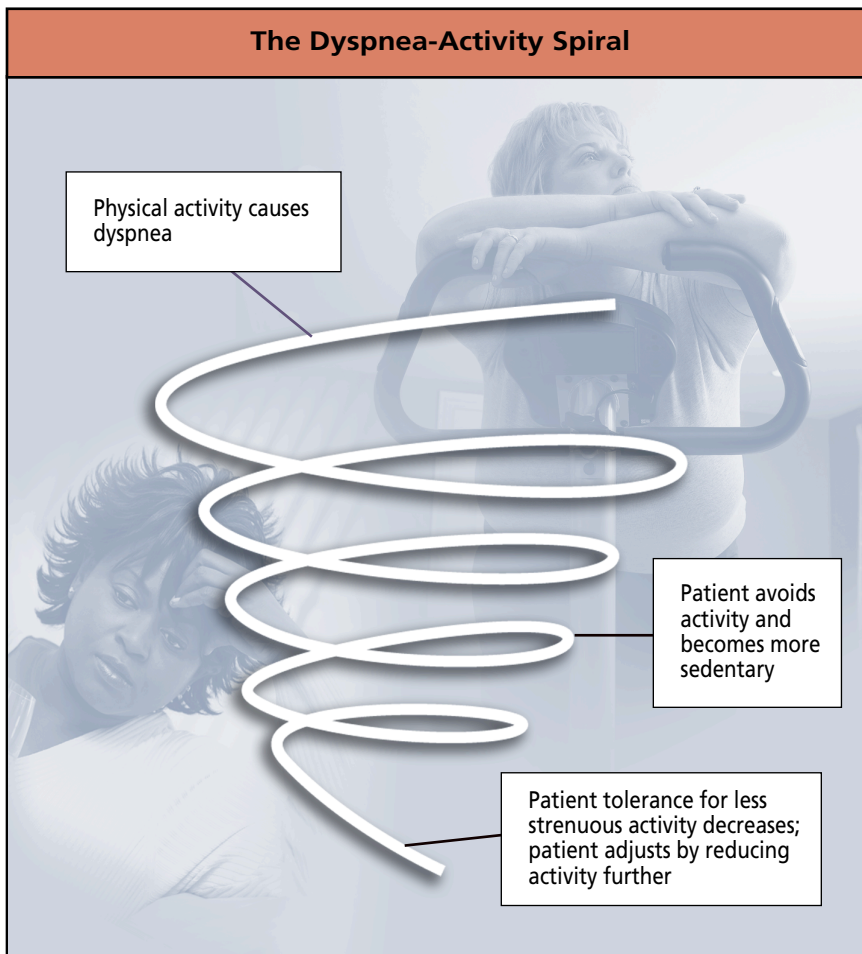
The Dyspnea-Activity Spiral

Physical activity causes dyspnea

Patient avoids activity and becomes more sedentary

Patient tolerance for less strenuous activity decreases; patient adjusts by reducing activity further

Figure 3. *Dyspnea activity spiral. Patients with chronic obstructive pulmonary disease may have dyspnea after performing certain activities, causing patients to avoid such dyspnea-inducing activities. However, as the patient becomes more sedentary, tolerance for activities decreases further, likewise decreasing patient activity.*

tant. This relationship entails a mutual giving and receiving of feedback and may either enhance or impair treatment adherence. In a climate of shared responsibility, dignity, and respect, best adherence is achieved.[52] Motivation is also needed to change behavior.

Three components contribute to the patient's motivation to change, as follows:

- perceived severity of the health condition
- perceived benefits outweighing the barriers to change
- a cue to action (often a severe exacerbation)[53]

Sparking motivation in the reluctant patient is often best accomplished when the patient-physician trust relationship is strong. For example, when a patient asks how he or she can possibly participate in an exercise program when he or she can't even walk to the bathroom, the physician might immediately demonstrate the pacing and breathing techniques one might use to accomplish this task, allowing the patient some extra time to practice the techniques with physician supervision and encouragement.

When outlining a treatment strategy for patients with COPD, it is important to address not only the physical symptoms but also quality of life issues. Therefore, a multifaceted approach, involving pharmacologic and nonpharmacologic options, is essential in treating the whole patient. However, the expression of belief in the patient and demonstration of the technique are essential to the success of such interventions.

Pharmacotherapy

Pharmacologic strategies may be used to reduce symptoms—primarily dyspnea—in hopes of improving a patient's quality of life. Although no medication has been proven to reduce COPD-related mortality, many studies[54-61] have shown that several pharmacotherapeutic options reduce

sion Questionnaire[46] and the Beck Depression Inventory.[47] However, a simple four- or five-question screening tool based on the Primary Care Evaluation of Mental Disorders can help identify patients with at least moderate anxiety or depressive symptoms.[48-50] When a patient appears depressed, professional psychiatric and psychological services should be considered.

Treatment Strategies

Symptom relief and improved physical functioning are among the most important outcomes to patients.[51] Therefore, management of cough, sputum production, dyspnea, and fatigue are imperative.

As defined by GOLD, the goals of treatment for patients with COPD are to relieve symptoms, increase functional status, prevent and treat complications and exacerbations, and reduce mortality.[1] By following these guidelines, physicians can assist patients in improving their overall quality of life.

Among the many factors affecting improvement in exercise, ADLs, and quality of life, the trust relationship between the patient and physician is perhaps among the most impor-

patient symptoms and disease complications.

Bronchodilator therapy, including short- (eg, ipratropium bromide) and long-acting anticholinergics (eg, tiotropium bromide) and short- (eg, albuterol) and long-acting β_2 agonists (eg, formoterol fumarate, salmeterol xinafoate) are mainstays of therapy for all patients with COPD. Methylxanthines (eg, theophylline anhydrous) are also bronchodilators, but they have been used sparingly in this patient population because of their potential for adverse effects.[1] Longer-acting bronchodilators have proven more effective,[54-59] and combinations of long acting β_2 agonists and anticholinergics have demonstrated synergistic effects.[60,61]

Tiotropium, the once-daily, long-acting, inhaled anticholinergic, not only reduces the rate of COPD exacerbations[59] but also improves the effectiveness of pulmonary rehabilita-

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■ **Questions to Evaluate Basic ADLs**
□ Are you able to wash and bathe yourself?
□ Are you able to climb stairs?
□ Are you able to move (ie, transfer) from a bed to a chair on your own?
□ Can you walk (and if so, how far)?
□ When was the last time you walked that far?
□ Are you able to feed yourself?
□ Do you have difficulty using the toilet for either bladder or bowel functions?
□ Are you able to groom yourself?

■ **Questions to Evaluate Instrumental ADLs**
□ Are you able to travel via car or public transportation?
□ Do you shop for your own food and clothes?
□ Who prepares your food for you?
□ How much of your own housework do you perform?
□ Can you make your bed?
□ Who ensures you take your medication on time and in the correct dose?
□ Do you manage your own money?
□ Are you able to engage in sexual activity?
□ Do you care for others?
□ Do you care for a pet?
□ Are you caring for children?
□ How do you get around?
□ Do you require a device to communicate with others?

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Figure 4. *To assess a patient's activities of daily living (ADLs), clinicians can ask the patient or his or her caregiver simple questions regarding basic daily activities. Likewise, to assess instrumental ADLs, physicians may further question the patient or caregiver to evaluate the "higher" capabilities. Physicians can use responses to gauge disease severity.*

tion.[54] A study by Celli et al[55] showed that patients treated with tiotropium for 4 weeks exhibited a statistically significant greater increase in FEV_1 and forced vital capacity (FVC) at all times compared to patients treated with placebo. These improvements were accompanied by improved lung volume in patients receiving tiotropium. The IC of patients in the tiotropium group increased by 300 mL compared to placebo ($P<.01$), giving patients more "room to breathe" by reducing static lung volumes and concomitant reduction in functional residual capacity. Patients in the tiotropium group were able to empty their lungs more completely and reduce the amount of trapped air.

In addition, as described in two studies,[56,57] patients taking tiotropium via inhaler once a day are able to exercise between 100 to 105 seconds longer than patients on placebo. A 2008 study[58] investigated the effects of tiotropium for 4 years and found improved lung function and quality of life and fewer exacerbations.

Inhaled glucocorticoid therapy has been recommended for symptomatic Stage III (severe) and IV (very severe) COPD and for patients with repeated exacerbations.[1,2] The recent TORCH (TOwards a Revolution in COPD Health) trial[60] evaluated mortality rates, frequency of exacerbations, health status, and spirometric values using the combined regimen of 50 μg of salmeterol and 500 μg fluticasone propionate inhaled twice daily. Although the reduction of death was not statistically significant compared to control groups, improvements in other outcomes were observed and reached statistical significance for the combined salmeterol and fluticasone group.[60]

Another large randomized trial[61] evaluated the combination of inhaled tiotropium with inhaled salmeterol, tiotropium with inhaled salmeterol-fluticasone, and tiotropium plus placebo. After 1 year, the group using the combination of tiotropium plus salmeterol-fluticasone had statistically significant improvements in lung function and disease-specific quality of life as well as a reduced number of hospitalizations for COPD and other causes.[61] However, differences in the rates of COPD exacerbations were not statistically significant.

All patients with COPD should receive an annual influenza vaccine. In addition, the pneumococcal polysaccharide vaccine is recommended for all COPD patients aged 50 years or older and for selected younger patients with reduced lung function (eg, FEV_1 lower than 40% predicted).[1,2] Prophylactic antibiotics, mucolytics, antitussives, and leukotriene modifiers are not currently recommended. Long-term oxygen therapy (more than 15 hours daily) in patients with chronic respiratory failure has been shown to increase survival and may improve exercise capacity and lung mechanics.

Self-Management Education

The goal of all patient education is to improve clinical outcomes by teaching self-management skills, thus increasing

- Help the patient set personally important, realistic, and measurable goals
- Tailor exercise to the patient's goals
- Encourage use of logs or diaries to keep track of improvement
- Review progress on a preset, regular basis
- Provide praise for attempts and accomplishments
- Help brainstorm solutions for barriers to compliance
- Provide skill training (eg, using pursed-lip breathing while climbing stairs) and monitor patient's ability to do it
- Provide opportunities for vicarious learning
- Help enlist a partner for social support
- Maintain regular telephone contact for questions, support, and problem-solving
- Help patient set up a system of reminders to achieve daily goals (eg, keeping exercise clothes and gear in a prominent place)

Figure 5. *Strategies for physicians to help patients with chronic obstructive pulmonary disease improve their self-efficacy and exercise adherence. The more strategies used, the more likely the patient will be able to succeed.*

self-efficacy and adherence. Traditionally, education has focused on supplying the patient with disease-specific information and appropriate technical skills. More recently, patient self-management education, which concentrates on teaching patients disease-related problem-solving skills, has been used to help patients identify personally important problems associated with their condition and overcome them by designing action plans with their physician.[62]

Improving patient self-efficacy includes addressing deficits in skills required in the treatment plan, encouraging patients to enlist the support of others in practicing new skills, and providing positive and constructive feedback on their experiences. *Figure 5* provides multiple strategies for physicians to improve patient self-efficacy and exercise adherence.

A well-designed, prospective, randomized clinical trial[63] has described the benefits of self-management education. The study[63] compared patients receiving standard care with patients enrolled in comprehensive skill-oriented self-management programs. At 1-year follow-up, patients in the self-management program had overall reductions in hospital visits, including fewer admissions for exacerbations (39.8%) and other health problems (57.1%).[63] In addition, self-management education was associated with 41% fewer emergency department and 58.9% fewer unscheduled physician visits. Also, HRQL was improved with self-management education at 4 months. Similarly, a randomized trial from Norway[64] showed improved outcomes and reduced costs in patients with COPD

who received self-management education after 1 year.

In contrast to these studies,[63,64] Monninkhof et al[65] did not find such positive results. Patient-reported exacerbations increased and there was no measured improvement in HRQL. The authors[65] concluded that self-management education was not an efficient or cost-effective treatment strategy.

The discrepancies in these trials may be a result of the fact that patients in the Monninkhof study[65] were stabilized at baseline, having already completed a 4-month inhaled corticosteroid substudy. These patients were also highly motivated, having agreed to participate in the two trials over 3 years. Also, compared with the patients in the Bourbeau trial,[63] they were younger, less educated, had less severe impairment, and had fewer exacerbations in the year preceding the trial.

As a result of these conflicting results and many anecdotal reports of patient satisfaction in the self-management education arm, a qualitative follow-up study[66] was conducted in a subgroup of 20 participants from the Monninkhof trial. During interviews, these 20 individuals expressed favorable experiences regarding the education program, including increased energy levels, emotional well-being, self-confidence, coping skills, and autonomy. These results suggest that questionnaires may not sufficiently capture the benefits of self-management education programs.

Despite the need for further evaluation in terms of cost-benefit analyses, providing patients with the tools they need to properly manage a complex disease is as important as prescribing a proper medication.[1]

Pulmonary Rehabilitation

Pulmonary rehabilitation is a comprehensive, multidisciplinary intervention designed to reduce symptoms and increase functional performance and HRQL in patients with COPD and other chronic respiratory conditions.[67,68] During the past decade, the body of theoretical and practical knowledge about pulmonary rehabilitation has grown to hold a prominent place in the GOLD document.[69] In many settings among various protocols and strategies, pulmonary rehabilitation has produced positive results for patients with symptomatic chronic respiratory diseases.[32,70-73] Pulmonary rehabilitation is viewed as integral to the lifelong management of COPD and should not be reserved to manage severe diseases only.[1,26]

As described earlier, exercise is foreign and frightening to the majority of COPD patients.[74] Physical training is important to prevent muscle deconditioning that occurs naturally as a consequence of inactivity, even in healthy individuals. These changes can be reversed with 6 weeks of exercise rehabilitation in both healthy patients and those with COPD.[75,76] However, dyspnea and fatigue must first be addressed before exercise training can be initiated.

Different components of pulmonary rehabilitation (eg,

education, desensitization to an exercise stimulus, optimizing pharmacologic therapy, cognitive-behavioral strategies) appear to modify specific aspects of physiologic and psychological functioning related to dyspnea and exercise.[77,78] In addition, oxygen therapy, anxiolytics, and pursed-lip breathing are thought to decrease central drive, while vibration, fan, and inhaled therapies are believed to alter pulmonary afferent information. Improvement in inspiratory muscle function can be achieved by better nutrition, inspiratory muscle training, positioning, and less steroid use. A reduction in airway resistance is achieved via drug therapy, correct use of delivery devices, and secretion clearance strategies.

Active COPD self-management is a major goal of pulmonary rehabilitation professionals. The therapies and strategies used in a comprehensive program encourage the required behaviors to promote self-management success,[79] as follows:

□ adequate coping
□ adherence with medication
□ attention to changes in disease severity
□ effective metered dose inhaler or dry powder inhaler technique
□ self-adjustment of medication during exacerbation

Improvement in functional performance is another major focus of pulmonary rehabilitation. Increased functional reserve is an important outcome, as determined by patients having "fewer symptoms and greater tolerance levels for intermittent performance demands."[80]

Functional performance is impaired by depression and anxiety in patients with COPD.[81] Pulmonary rehabilitation has been shown to benefit anxiety and depressive symptoms as well as exercise tolerance, dyspnea, and HRQL.[82] In a randomized trial of exercise, education, and stress management among patients with COPD, Emery[83] found that patients who received all three components improved endurance, reduced anxiety, and improved cognitive performance. Guell and colleagues[32] showed that pulmonary rehabilitation decreased psychosocial morbidity even when no specific psychological intervention was included in the program.

Improvements in aerobic fitness have also been shown to improve gains in cognitive performance after exercise intervention.[84,85] Patients with depression and anxiety at program entry also responded well to pulmonary rehabilitation. The most positive outcomes are reported when patients with difficult psychosocial problems are treated using a multidisciplinary approach.[86-88] The many documented improvements in HRQL include:

□ fewer symptoms, especially dyspnea and fatigue
□ decreased frequency of exacerbations
□ increased ability to exercise
□ increased frequency, intensity, and types of exercise done
□ increased feeling of being in control

Pulmonary rehabilitation is not simply a brief program with a beginning and an end, but a commitment to a lifestyle change. If long-term improvement is to be maintained, adherence to exercise must be continued. Ongoing intermittent reinforcement is needed if exercise gains are to be maintained.[70]

Surgical Options

Lung volume reduction surgery has been shown to increase exercise tolerance by improving lung mechanics and reducing hyperinflation.[89] It is most successful in patients with upper lobe emphysema and low exercise capacity as measured by greater survival benefit and improved lung function.[89]

With advances in immunosuppression and better understandings of the timing of interventions and selection of candidates, lung transplantation has become a realistic option. Interestingly, though transplant normalizes lung function, exercise tolerance is not normalized.[90] This finding underscores the importance of physicians using nonpulmonary factors to determine exercise tolerance in patients with COPD.

Osteopathic Manipulative Treatment

A variety of techniques have been developed by osteopathic medical professionals specifically for improving pulmonary function, but results are mixed.[91,92] In a recent randomized controlled trial of 35 subjects with COPD (FEV_1/FVC ratio <70%) and aged 65 years or older, subjects were assigned to receive osteopathic manipulative treatment (OMT) or sham therapy.[93]

The OMT group had a statistically significant increase in residual volume and total lung capacity as well as a decrease in the forced expiratory flow at 25% and 50% of vital capacity as compared with the sham group.[93] Although the overall pattern suggested a worsening of airway obstruction, most subjects (82% in the OMT and 65% in the sham therapy group) reported breathing better after receiving their treatment.[93] However, because multiple techniques were used, it was difficult to determine the contribution of each OMT technique to the final outcome.

Conclusion

As healthcare providers, we frequently underestimate the impact of chronic illness on our patients with COPD. In a society that emphasizes doing and not just being, it is important for patients to maintain the highest level of functioning. The combination of symptoms and the life changes resulting from an inability to exercise affect ADLs, which further contribute to impaired HRQL. It is important that physicians understand the physiologic link between hyperinflation and dyspnea as a result of poor ventilatory function.

Several pharmacologic and nonpharmacologic interventions may be used to improve patient exercise tolerance and, subsequently, quality of life. Successful outcomes will most likely occur when pulmonary rehabilitation is individualized for each patient, taking into consideration their unique personal goals as well as their life and health-related circumstances.[94]

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