

# Diagnosing and treating COPD: understanding the challenges and finding solutions

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**Abstract:** Chronic obstructive pulmonary disease (COPD) is characterized by airflow obstruction that is not fully reversible; symptoms include chronic cough, sputum production, and dyspnea with exertion. An estimated 50% of the 24 million adults in the USA who have COPD are thought to be misdiagnosed or undiagnosed. Factors contributing to this include a low awareness of COPD and the initial symptoms of the disease among the general population, acceptance of these symptoms as a consequence of aging or smoking, some symptomatic similarity to asthma, and failure of health care personnel to use spirometry for diagnosis. Increased familiarization with COPD diagnosis and treatment guidelines, and proactive identification of patients with increased risk of developing COPD through occupational, environmental, or lifestyle exposures, will assist in a timely, accurate diagnosis and effective treatment, which will consequently improve patient outcomes. This review addresses the issues surrounding the diagnosis and misdiagnosis of COPD, their consequences, and how COPD can be better managed within primary care, including consideration of COPD care in patient-centered medical home and chronic care models.

**Keywords:** primary care, undiagnosed, misdiagnosed, chronic care model, patient-centered medical home

## Introduction: definition of COPD, disease impact on patients, and epidemiology

Chronic obstructive pulmonary disease (COPD), which is characterized by partially reversible airflow obstruction, is primarily caused by exposure to cigarette smoke and other occupational and environmental pollutants;<sup>1</sup> the widely used definitions of COPD are shown in Table 1.<sup>2-6</sup> The most common symptoms of COPD include chronic cough, abnormal sputum production, and dyspnea with exertion.<sup>7</sup> This disease further impacts patients through reduced lung function and reduced quality of life (QoL).<sup>8-10</sup> The reduction in lung function is progressive and leads to exercise intolerance, a consequent reduction in activity as patients avoid the discomfort of breathing difficulties, and continued physical decline.<sup>11</sup> As the disease advances, symptoms worsen, exacerbations increase in frequency and severity, and lung function is further compromised, causing a downward spiral of events until death eventually occurs (Figure 1). The patient's QoL, rate of decline, frequency of exacerbations, and emergency hospitalizations can all be influenced and improved by lifestyle interventions and pharmacologic treatment.<sup>3,4,12-14</sup>

Unfortunately, COPD is not a rare condition and an estimated 50% of the 24 million adults in the USA who have COPD are thought to be misdiagnosed or undiagnosed.<sup>15</sup>

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**Table 1** Definitions of chronic obstructive pulmonary disease

Organization	Definition
American Thoracic Society/European Respiratory Society (ATS/ERS) <sup>2</sup>	Chronic obstructive pulmonary disease (COPD) is a preventable and treatable disease state, characterized by airflow limitation that is not fully reversible. The airflow limitation is usually progressive and is associated with an abnormal inflammatory response of the lungs, to noxious particles or gases, primarily caused by cigarette smoking. Although COPD affects the lungs, it also produces significant systemic consequences.
Canadian Thoracic Society (CTS) <sup>3</sup>	Chronic obstructive pulmonary disease (COPD) is a respiratory disorder largely caused by smoking, and is characterized by progressive, partially reversible airway obstruction and lung hyperinflation, systemic manifestations, and increasing frequency and severity of exacerbations.
Global Initiative for Chronic Obstructive Lung Disease (GOLD) <sup>4</sup>	COPD is a preventable and treatable disease with some significant extra-pulmonary 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.
National Institute for Health and Clinical Excellence (NICE) <sup>5</sup>	COPD is characterized by airflow obstruction. The airflow obstruction is usually progressive, not fully reversible and does not change markedly over several months. The disease is predominantly caused by smoking.
World Health Organization (WHO) <sup>6</sup>	Chronic obstructive pulmonary disease (COPD) is a lung disease characterized by chronic obstruction of lung airflow that interferes with normal breathing and is not fully reversible.

The aim of this review is to identify the issues surrounding the diagnosis and misdiagnosis of COPD, their consequences, and to address how this situation can be better managed in primary care.

## Methods

Medline searches (using PubMed) were carried out using variations and combinations of the following keywords: COPD, undiagnosed, underdiagnosis, prevalence, treatment, patient-centered medical home (PCMH), and asthma. Bibliographies of articles were examined to identify further citations. All nonhuman studies and articles in languages other than English were excluded.

## Barriers to COPD diagnosis and treatment

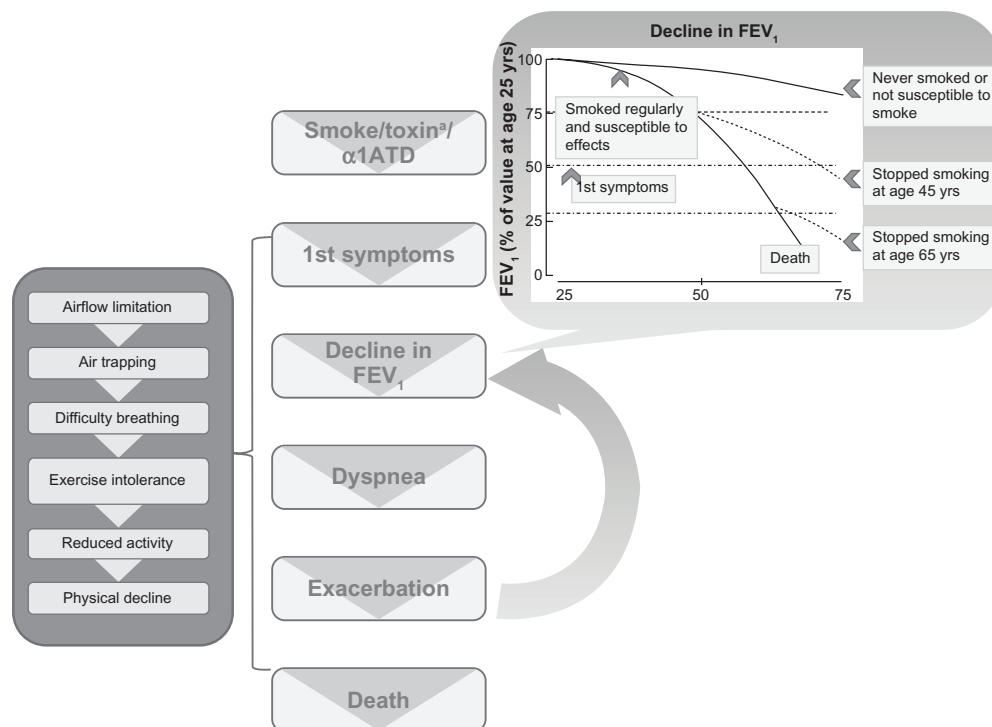
### Primary care practitioner– and practice-related barriers

Lack of awareness and knowledge about COPD are major reasons why primary care practitioners (PCPs) and other health care providers may delay or incorrectly diagnose COPD. Results from a survey of American family physicians, nurse practitioners (NPs), and physician's assistants (PAs) ( $n = 284$ ) indicated that fewer than 50% of this test group reported knowledge or use of COPD diagnosis and treatment guidelines,<sup>16</sup> suggesting that familiarity with diagnosis and treatment guidelines, and implementation of the recommendations, could be more widespread.

Often, recognition of COPD does not occur until the disease has progressed to moderate or severe stages,<sup>17–19</sup> by which time patients' symptoms have worsened; they have a poor QoL and a rapidly declining condition. This trend toward late recognition of the disease may persist in spite of a growing body of scientific literature on COPD and updated disease guidelines (Table 2).<sup>2–5</sup> Guidelines for COPD diagnosis (Table 2)<sup>2–5</sup> have been developed to help PCPs recognize patients with symptoms and those at risk of developing COPD; therefore awareness of and adherence to these guidelines can help in the early diagnosis of COPD.

Some degree of therapeutic nihilism may also contribute to COPD remaining undiagnosed or undertreated. Data from a test group of 284 physicians, NPs, and PAs showed that only 15% of this group thought that treatment improved COPD symptoms, 13% thought longevity could be extended by COPD treatment, and 3% thought that it reduced exacerbations or that pulmonary rehabilitation was useful.<sup>16</sup>

Obtaining an early diagnosis of COPD can be challenging for PCPs, as patients with mild COPD and a smoker's cough may experience little impact on breathing ability and no obvious additional abnormal symptoms.<sup>20</sup> Although smoking is the major cause of COPD, risk factors also include exposure to occupational dusts and air pollution, repeated childhood respiratory infections, poor nutrition, and  $\alpha$ 1-antitrypsin deficiency; therefore, to focus solely on patients who smoke may also contribute to underdiagnosis of COPD. Individuals who are nonsmokers, but who are regularly exposed to secondhand smoke should also be considered at risk of COPD. A study by Bednarek et al<sup>21</sup> indicates the importance of considering a diagnosis of COPD for nonsmokers and smokers alike, as detection of COPD in this study would have been reduced by 26% if a "smokers only" criterion had been applied.



**Figure 1** Disease course of chronic obstructive pulmonary disease.

**Notes:** The decline in forced expiratory volume in 1 second ( $FEV_1$ ) graph is adapted from Fletcher and Peto, 1977.<sup>9</sup> Reproduced from “The natural history of chronic airflow obstruction,” *British Medical Journal*, C Fletcher, R Peto, Vol 1, 1645–1648, copyright 1977 with permission from BMJ Publishing Group Ltd. #Refers to an inhaled occupational/environmental toxin.

**Abbreviation:**  $\alpha$ 1AHD,  $\alpha$ 1-antitrypsin deficiency.

Failure to use appropriate diagnostic tools could further contribute to under- or misdiagnosis.<sup>22,23</sup> Despite spirometry being a vital tool to establish a diagnosis of COPD, it is widely underutilized, even if available in a medical practice.<sup>24,25</sup> A survey of 943 PCPs found that, although 64% of practices had access to spirometry, only 34% regularly used it.<sup>26</sup> This situation does not appear to improve when the patient’s disease state is severe enough to warrant hospitalization. A retrospective review of 553 patients, hospitalized with respiratory failure or undergoing ventilator support, with a follow-up period of up to 8 years, found that only 31% of these patients had their diagnosis confirmed by spirometry, despite having a clinical diagnosis of COPD.<sup>27</sup> To address these deficiencies, adequate training of PCPs and their practice staff in spirometry use and data interpretation is warranted.<sup>25,28</sup>

Diagnosis of COPD can also be hampered by diagnostic confusion between asthma and COPD.<sup>29</sup> When patients present with cough, shortness of breath, and diminished exercise tolerance, there is a bias toward diagnosing asthma, particularly in women.<sup>30</sup> In a study of 597 patients, Tinkelman et al<sup>29</sup> found misdiagnosis of asthma and COPD to be common (approximately 40% previously diagnosed

with asthma had COPD). Financial factors may also influence the bias toward asthma diagnosis because, in the USA, there is often a “pay for performance” incentive for PCP diagnosis of asthma but there is not for COPD. This is in contrast with the situation in the UK, where incentives have been introduced to promote and improve diagnosis, management, and quality of care for patients with COPD and asthma.<sup>31,32</sup> Early indications are that the introduction of these incentive programs is leading to improved quality of care, and that there has been an increase in the use of spirometry and subsequent diagnosis of COPD in the UK.<sup>32,33</sup> In the instance of misdiagnosis of COPD as asthma, patients receive treatment that is incorrect, which consequently fails to address their symptoms adequately.<sup>31</sup> This is highlighted by a study of 328 patients with assumed asthma that found that 34% of the patients, in fact, had COPD.<sup>34</sup>

## Patient-related barriers

It is important to recognize that patients also display a lack of awareness of COPD: failing to identify symptoms at the start of disease, accepting breathlessness and reduced exercise tolerance as part of normal aging, or attributing cough and sputum to their smoking habit. Unconsciously, such patients

**Table 2** Comparison of guidelines for the diagnosis and treatment of chronic obstructive pulmonary disease

Content	ATS/ERS	GOLD	NICE	CTS
Pages	222	113	54	28
Diagnosis/Disease staging	✓	✓	✓	✓
Risk factors	✓	✓		✓
Natural history	✓	✓		
Pathology, pathogenesis, and pathophysiology	✓	✓		✓
How to test for COPD	✓	✓		✓
Stable COPD management	✓	✓	✓	✓
Smoking cessation	✓	✓	✓	✓
Pharmacotherapy	✓	✓	✓	✓
Pulmonary rehabilitation	✓	✓	✓	✓
Long-term O <sub>2</sub>	✓	✓	✓	✓
Nutrition	✓	✓	✓	
Surgery	✓	✓		✓
Sleep	✓			
Air travel	✓		✓	
Exacerbation	✓	✓	✓	✓
Palliative care	✓		✓	✓
Integrated disease management	✓	✓	✓	
Separate patient guide (80 pages)	Answers series of questions			
Patient education		✓	✓	✓
Translating guideline in primary care		✓		8 page summary for primary care <sup>3</sup>
Follow-ups and monitoring	✓	✓	✓	✓
Case scenarios				✓

**Abbreviations:** ATS/ERS, American Thoracic Society/European Respiratory Society; GOLD, Global Initiative for Chronic Obstructive Lung Disease; NICE, National Institute for Health and Clinical Excellence; CTS, Canadian Thoracic Society; COPD, chronic obstructive pulmonary disease.

adapt their lifestyle to compensate for their deteriorating health, until they have progressed to a stage where they have substantial and irreversible loss of lung function, and the impact is so severe that patients consider seeking medical opinion and intervention.<sup>35,36</sup>

Evidence from the literature suggests that early diagnosis and appropriate early treatment are beneficial for patients in terms of reduction of symptoms and improvement in QoL.<sup>37,38</sup> For example, smoking cessation, which is the most effective intervention for improving disease course and survival in the early stages of COPD, can be encouraged and appropriate therapies started while the patient still has relatively intact lungs.<sup>38–40</sup> However, this therapeutic goal may prove elusive, as patients also avoid discussing their COPD symptoms with a PCP because they harbor guilt about their smoking history.<sup>41</sup> Such patient concerns can be alleviated by careful discussion to increase their knowledge base, providing support in smoking cessation, and giving priority to COPD treatment, regardless of smoking status,<sup>42</sup> similar to the unbiased, proactive treatment given to patients with cardiovascular disease, irrespective of their dietary habits.<sup>43</sup> When PCPs take this type of positive action to give treatment early in the course of

disease, patient prognosis and QoL can be improved. Despite receiving PCP support, some patients may not be successful in smoking cessation programs, but COPD treatment can still improve the patient's everyday QoL.<sup>17,38,44</sup>

Overall, the ongoing gap between PCP-diagnosed and actual COPD cases clearly illustrates that there is room for improvement in the level of knowledge regarding this disease and current treatment practices; examples in the literature exemplify the positive impacts of guideline implementation and of identifying and addressing barriers to diagnosis.<sup>45</sup>

## Making changes in practice to improve the diagnosis and treatment of COPD

### Diagnosis

Comprehensive guidelines have been developed by expert teams to aid diagnosis and treatment of patients with COPD. The available guidelines include those from the American Thoracic Society/European Thoracic Society (ATS/ERS),<sup>2</sup> the Global Initiative for Chronic Obstructive Lung Disease (GOLD),<sup>4</sup> the National Institute for Health and Clinical Excellence (NICE) in the UK,<sup>5</sup> and the Canadian Thoracic

Society (CTS).<sup>3</sup> These guidelines share the same treatment goals but differ in the extent of detail and some recommendations; the ATS/ERS and GOLD guidelines are the most comprehensive, while the CTS guidelines include examples of case management that may occur in everyday practice (Table 2). PCPs, PAs, and NPs should be aware of, and familiar with, the COPD guidelines to ensure an early diagnosis and optimum management of COPD.

Another step toward improving the diagnosis of COPD is to have strategies in place to identify patients who may be at risk. There are suggested strategies in the diagnosis and treatment guidelines: the GOLD guidelines recommend a COPD evaluation for patients > 40 years old, with activity limitation, breathlessness, cough, and a history of smoking or occupational/environmental exposure,<sup>4</sup> while a lower age of 35 years has been suggested by the “ABC of chronic obstructive pulmonary disease”<sup>46</sup> for initiating evaluation of patients who have identified risks of developing COPD and are exhibiting preliminary symptoms.

Although the majority of patients with COPD have a smoking history (more than 50% of smokers will develop COPD),<sup>20</sup> the respiratory symptoms of nonsmokers should also be evaluated for COPD diagnosis.<sup>47</sup> If a nonsmoking patient has symptoms of cough, shortness of breath, diminished exercise tolerance, and expectoration, questioning by the PCP to establish whether occupational/environmental exposures could have caused the symptoms is recommended and, if these are ruled out, these individuals should be screened for  $\alpha$ 1-antitrypsin deficiency as a cause of COPD.

Currently, there are new screening initiatives under development and evaluation to identify patients at risk of developing COPD or who are already symptomatic. Such initiatives include a two-step lung function questionnaire<sup>48,49</sup> and a three-step screening strategy, which includes the following steps: (1) assess symptoms with a questionnaire; (2) for those patients where Step 1 identifies a risk of COPD, a baseline spirometry test should be performed; and (3) if baseline spirometry shows an abnormality, perform postbronchodilator spirometry. To improve the early diagnosis of patients with COPD, both the two-step and three-step strategies have the potential to be implemented in everyday practice.

Once patients at risk of COPD have been identified, the next step is to follow up with the tools that can confirm diagnosis. It is important to ensure that there are NPs, respiratory therapists, PCPs, or specialists who can efficiently and successfully champion patient spirometry, which is as essential to respiratory practice as electrocardiography is to cardiovascular investigations. As an example of how

frequently spirometry might actually be required in diagnosis on a daily basis, if a PCP saw 20 patients per day, who were representative of the population of the National Health and Nutrition Examination Survey (NHANES) III, five patients may have respiratory symptoms and a further three patients may have COPD.<sup>50</sup> With decreasing costs for baseline spirometry and the possibility of reimbursement for primary care spirometry,<sup>51</sup> the spirometer is becoming an affordable piece of equipment that will rapidly pay for itself, which will enable a wider uptake of this methodology.

## Differentiating COPD from asthma

It is essential to differentiate COPD from asthma to ensure correct treatment choices and optimal patient outcomes;<sup>52</sup> this can be facilitated by a good understanding of the differences between COPD and asthma. Both COPD and asthma are associated with inflammation and a reduced rate of pulmonary airflow, but they can be distinguished by their differing causes and inflammatory mechanisms. In COPD, irritants, such as smoke, activate lung epithelial cells to release chemotactic factors, which in turn activate pathways that cause elastin degradation, emphysema, mucus hypersecretion, and small airway fibrosis.<sup>53</sup> In asthma, triggers cause immunoglobulin activation of mast cells and pathways leading to bronchoconstriction and inflammation.<sup>53</sup>

COPD and asthma can be differentiated by pre- and postbronchodilator spirometry because airway obstruction is only partially reversible in COPD, while it is fully reversible in asthma.<sup>54,55</sup> There may also be differences between the symptoms and medical histories of patients with COPD and asthma. Often, patients with COPD are older than 35 years, have a history of smoking, and may suffer from a persistent, worsening, productive cough. In contrast, asthma can occur at any age but often starts in childhood or adolescence and is characterized by an intermittent dry cough and wheezing. The distinctions between COPD and asthma diagnosis and treatment are summarized in Tables 3 and 4.<sup>3,4,56</sup>

Correct diagnosis and treatment can be further complicated in patients where asthma and COPD coexist;<sup>4</sup> in a study of 597 patients with obstructive lung disease, almost 25% had both asthma and COPD.<sup>29</sup> In such individuals, it is difficult to differentiate between the two diseases, so additional investigations such as chest X-rays may sometimes detect hyperinflation, flattening of diaphragm domes, and basilar markings in COPD, which would normally be absent in patients with asthma.<sup>57</sup> Establishing the inflammatory cell profile in bronchoalveolar lavage fluid or sputum may also be used to identify COPD and asthma, as elevated levels of



**Table 3** Differential diagnosis of chronic obstructive pulmonary disease and asthma

Diagnostic features	COPD		Asthma	
Onset age	Usually >35 years		Typically during childhood/adolescence, but can be any age	
Allergic hypersensitivity	Family/Personal history rarely a factor		Usually family/personal history	
Smoking history	Often >20 pack-years <sup>a</sup>		Possible but not necessarily	
Symptom occurrence	Chronic and persistent		Intermittent; usually symptom free	
Cough	Persistent and productive		Intermittent and nonproductive	
Breathlessness	Progressive and persistent		Intermittent and variable	
Disease course	Progressive worsening (with exacerbations)		Stable (with exacerbations)	
Nocturnal symptoms	Uncommon unless severe disease state		Common	
Cause of exacerbations	Bacterial/viral respiratory tract infection		Allergens, cold air, or exercise	
<b>Spirometry determined GOLD COPD stage/asthma state</b>	<b>FEV<sub>1</sub><sup>b</sup></b>	<b>FEV<sub>1</sub>/FVC</b>	<b>FEV<sub>1</sub><sup>b</sup></b>	<b>FEV<sub>1</sub>/FVC</b>
Mild/intermittent	≥80%	<0.70	>80%	Normal <sup>c</sup>
Moderate/mild persistent	50%–79%	<0.70	>80%	Normal <sup>c</sup>
Severe/moderate persistent	30%–49%	<0.70	60%–79%	Reduction ≤5% of normal
Very severe/severe persistent	<30% or <50% with CRF	<0.70	<60%	Reduction >5% of normal
Response to bronchodilators	Variable, PFT does not normalize but may show improvement		Rapid response and PFT may greatly improve eg, FEV <sub>1</sub> improves >0.4 L after SAB	

**Notes:** <sup>a</sup>Total number of pack-years is calculated = (number of cigarettes smoked per day/20) × number of years smoking (O'Donnell et al, 2008<sup>3</sup>); <sup>b</sup>% of predicted value; <sup>c</sup>normal FEV<sub>1</sub>/FVC values for patients aged 8–19 years = 85%, 20–39 years = 80%, 40–59 years = 75%, and 60–80 years = 70%.<sup>3,4,17,20,37,46,55</sup>

**Abbreviations:** GOLD, Global Initiative for Chronic Obstructive Lung Disease; COPD, chronic obstructive pulmonary disease; FEV<sub>1</sub>, forced expiratory volume in 1 second; FVC, forced vital capacity; CRF, chronic respiratory failure; PFT, pulmonary function test; SAB, short-acting bronchodilator.

neutrophils are characteristic of COPD but not of asthma, and increased levels of eosinophils are characteristic of asthma but not of COPD.<sup>53,55,58</sup>

## Treating COPD

Although not curable, COPD can be treated at any stage of the disease.<sup>3</sup> The goals of COPD treatment are to relieve symptoms, prevent disease progression, improve exercise tolerance, improve QoL, prevent and treat exacerbations, and reduce mortality.<sup>4</sup> The guidelines that provide information to assist diagnosis of COPD also have recommendations for patient treatment, which include strategies to minimize risk, lifestyle changes, and pharmacotherapy.<sup>2–5</sup> The appropriate treatment depends on the patient, and should take into consideration factors such as their current exposure to lifestyle/environmental/occupational risk factors and the severity of disease (Figure 2). If the patient is a current smoker at the time of diagnosis, support in smoking cessation should be given by the PCP, because it effectively reduces the rate of lung function decline. Providing vaccination against influenza to all patients with COPD, and against pneumonia to patients

aged ≥65 years and to those with forced expiratory volume in 1 second (FEV<sub>1</sub>) <40% can also to help reduce the occurrence of exacerbations.

The pharmacologic treatment of COPD is centered on the use of bronchodilators (β-2 agonists and anticholinergics) and inhaled corticosteroids.<sup>4</sup> Depending on the severity of disease, the bronchodilators may be administered as required or as long-term maintenance therapy.<sup>4</sup> Combination therapy with bronchodilators and inhaled corticosteroids is used to achieve effective bronchodilation as disease severity and pulmonary obstruction increase, with inhaled corticosteroids added to the treatment regime when a severe stage of disease is reached.<sup>4,59</sup> Patients with severe COPD may also have hypoxemia and/or hypercapnia, which can be improved by the use of supplemental oxygen; this treatment can also lead to improvements in the patients' exercise capacity.<sup>60</sup>

These treatments are effective ways of meeting the goals of COPD management. A beneficial addition to pharmacotherapy is participation by the patient in pulmonary rehabilitation, which is recommended for all patients with

**Table 4** Differential treatment of chronic obstructive pulmonary disease and asthma

Treatment	COPD	Asthma
Smoking cessation	Recommended, as smoking accelerates decline of lung function	Recommended, as smoking exacerbates condition
Air pollution	Avoid	Avoid
Allergen	–	Avoid/Reduce
Influenza vaccination	Recommended	Recommended
ICS <sup>3,4,5,6</sup>	Not first-line therapy, reserved for use in severe/very severe COPD in combination with long-acting bronchodilator	Preferred therapy for inflammation in persistent asthma
β-2 agonists	Short-acting for short-term therapy at any disease state; long-acting β-2 agonists recommended in moderate and severe, if short-acting β-2 agonists not effective	Recommended with ICS, if asthma not well controlled with ICS alone
Anticholinergics	Short-acting and long-acting anticholinergics are recommended for moderate to severe COPD	Can be an option if β-2 agonists not well tolerated, but variable responses; not indicated in the USA for asthma
Systemic steroids	Used for exacerbation treatment	Used in severe asthma, for exacerbation treatment
Theophylline	Bronchodilators preferred, due to potential side effects of theophylline	Considered after bronchodilators and ICSs, due to potential side effects of theophylline
Oxygen	In advanced cases of COPD, when oxygen saturation is 88% or lower	For exacerbation management

**Abbreviations:** COPD, chronic obstructive pulmonary disease; ICS, inhaled corticosteroid.

COPD.<sup>3,4,13</sup> A pulmonary rehabilitation program can benefit patients with COPD by providing education and support to change behaviors, such as smoking cessation, improvement in nutrition, and adherence to the prescribed medication regimen.<sup>61</sup> Exercise training is a central component of pulmonary rehabilitation, which benefits patients by inducing changes in muscle biochemistry, resulting in improved muscle function.<sup>61</sup> These changes delay the fatigue that is associated with lactic acidosis and enable patients to achieve enhanced exercise tolerance and consequential improvement in QoL.<sup>61</sup> Exercise training also reduces dyspnea and

increases expiratory time, thereby reducing dynamic hyperinflation.<sup>61</sup> In addition, a recent review observed that pulmonary rehabilitation can increase motivation, self-efficacy for exercise, and functional capacity for physical activity, thereby enhancing activity and participation in extended activities of daily living.<sup>62</sup>

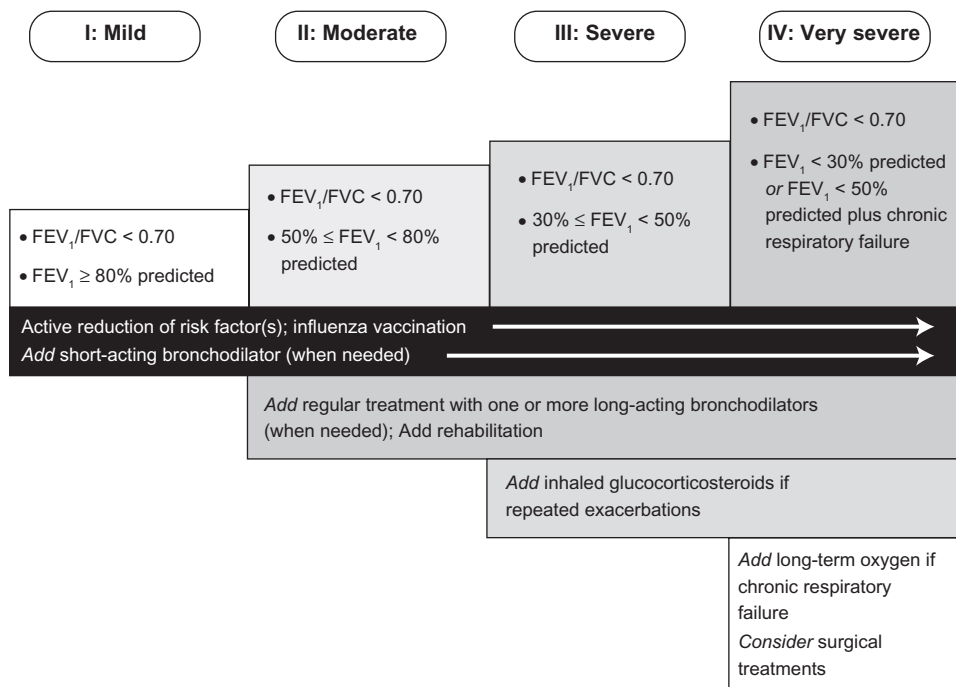
## The patient-centered medical home – a chronic care model for COPD

Care for many patients with COPD is not optimal because it consists of rescue therapy during hospital visits for episodic exacerbations, with little or no treatment follow-up, rather than the recommended lifestyle change, long-term maintenance pharmacotherapy, and pulmonary rehabilitation. There is a need to move away from the rescue treatment approach toward a more patient-centric care model incorporating regular planned care. The chronic care model (CCM) provides a solution based on high-quality care focused on the following components.<sup>63</sup>

1. Enabling patient self-management by providing education, tools, motivation, and support to modify behaviors. Patients should be encouraged to be active participants in their medical care, tracking changes and reporting symptoms.
2. Establishing a practice team (ie, respiratory therapists, NPs, and PCPs), who give patients regular planned care and access to medical care, 24 hours a day, 7 days a week.
3. Implementing diagnostic and management guidelines that facilitate disease state management (eg, ATS/ERS, GOLD, NICE, or CTS) and provide continuity of care with referrals for comorbid conditions. The performance against guideline benchmarks should be assessed.
4. Applying population-based care and providing feedback to the clinical information systems (eg, registries).

Although there are limited data on the effectiveness of a CCM in COPD treatment, systematic reviews have shown that the model significantly reduces hospitalizations and the duration of emergency room visits when two or more of the above components are implemented.<sup>63,64</sup> In addition to reducing health care utilization, application of a CCM to patients with COPD has also been shown to improve patients' QoL.<sup>65</sup>

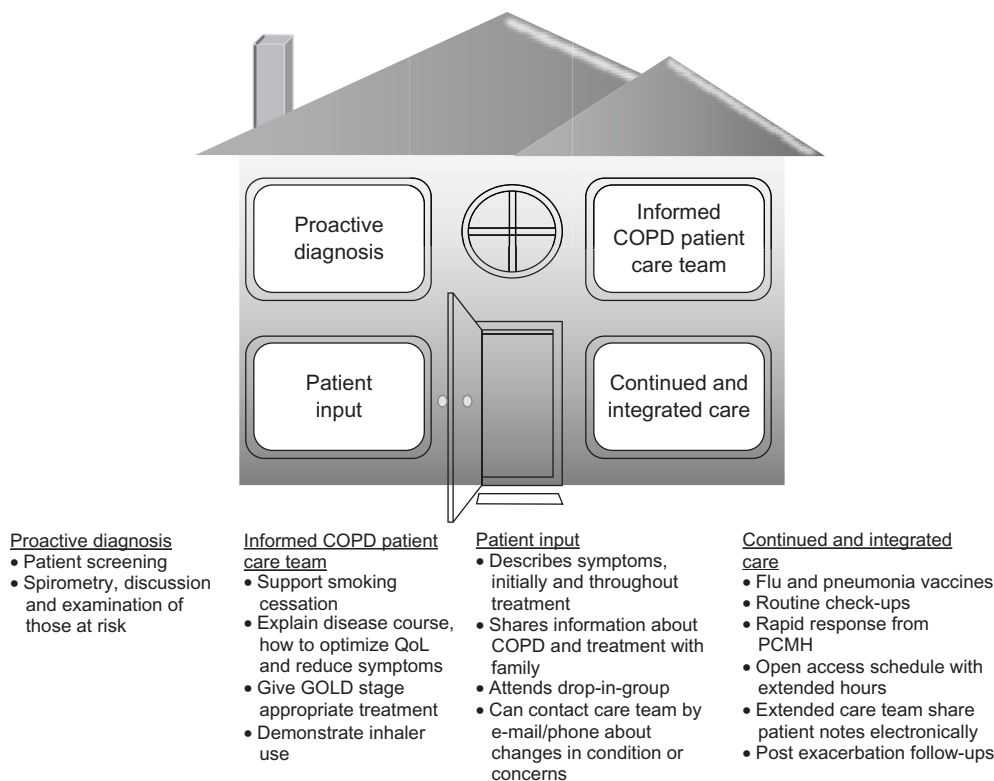
The CCM suggestions for patients with COPD are aligned with the tenets of the patient-centered medical home (PCMH) (Figure 3), the principles of which were developed jointly by the American Academy of Family Practice, American College of Physicians, American Academy of Pediatrics, and American Osteopathic Association.<sup>66</sup>



**Figure 2** Therapy at progressing stages of chronic obstructive pulmonary disease.<sup>4</sup>

**Note:** From the *Global Strategy for Diagnosis, Management and Prevention of COPD, updated 2010* used with permission from the Global Initiative for Chronic Obstructive Lung Disease (GOLD), [www.goldcopd.org](http://www.goldcopd.org).

**Abbreviations:**  $FEV_1$ , forced expiratory volume in 1 second; FVC, forced vital capacity.



**Figure 3** Chronic obstructive pulmonary disease care in a patient-centered medical home (PCMH).

**Abbreviations:** COPD, chronic obstructive pulmonary disease; GOLD, Global Initiative for Chronic Obstructive Lung Disease; QoL, quality of life; PCMH, patient-centered medical home.



The PCMH is a refinement of and complement to the CCM<sup>67</sup> and involves a multidisciplinary team that is focused on maintaining wellness rather than merely reacting to acute illness.<sup>66</sup> The PCMH team is led by a PCP, who guides patient education, is the first point-of-care contact, and oversees continuous care. The core principles inherent to chronic COPD care practiced in a PCMH include proactive diagnosis, informed COPD patient care team, patient input, and continued and integrated care (Figure 3). Spirometry features prominently as part of the proactive diagnosis tenet. For instance, in managing a patient's care across different settings over time, a patient could be referred to a pulmonary function laboratory should the practice not have office spirometry or a pulmonologist available. Sharing of medical information via electronic means will also provide all the relevant health care providers with a patient's pulmonary function readings and other results needed to develop a long-term COPD management plan (eg, risk reduction measures, medication use, increasing physical activity) to improve whole patient care and long-term well-being.<sup>68</sup>

A central feature of the PCMH is to consider the patient and all their comorbid conditions simultaneously, rather than focusing on just one disease in isolation. This approach is of particular relevance to the care of patients with COPD, who often have multiple comorbidities and resulting polypharmacy. To facilitate care, patients receive enhanced access to care when needed, while ensuring against overtreatment, and also receive extended hours and longer consultations with various team members as appropriate. In addition to traditional consultations, extended care can also include telephone and e-mail access or involvement in a specific patient group. All aspects of the PCMH should be monitored for quality and safety, to enable continual improvements to be made.<sup>69,70</sup>

Given the lack of research within the USA on the application and effectiveness of CCM and PCMH principles to COPD in the clinic, more research is needed on the clinical integration of evidence-based science in COPD.

## Conclusion

Underdiagnosis and misdiagnosis of COPD leave patients with a reduced QoL and, potentially, a more rapidly progressing disease. In this respect, patients do not receive adequate care. Although guidelines and tools for the diagnosis of COPD are readily available, practitioner- and patient-related barriers can prevent an early diagnosis of this disease. Early diagnosis and management of COPD can improve long-term prognosis, giving patients the best opportunities to stop smoking, improve their QoL, reduce their symptoms, and reduce and

delay both exacerbations and hospitalizations. To achieve earlier diagnosis and high standards of care for patients with COPD, improvements may be required at several levels within the health care system, including the utilization of patient care models such as the CCM and PCMH, and regular implementation of diagnosis and treatment guidelines by health care teams, together with provision of regular education and support to patients and their care providers.

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