2

Clinical Assessment of COPD

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Key Points:

- Chronic obstructive pulmonary disease (COPD) should be suspected in any patient aged 40 years or more with symptoms of cough, sputum production, or breathlessness and/or a history of exposure to risk factors, in particular smoking. When seeing patients with respiratory symptoms or smokers – think of COPD
- Do spirometry
- Exclude differential diagnoses, perform chest x-ray
- Assess functional impairment, by interview and even better by testing
- When possible, standardize your questioning
- Consider further physiological testing or imaging
- Calculate BMI, it has prognostic value

Keywords COPD • diagnosis • breathlessness • symptoms

Diagnosis and Differential Diagnosis

The current definition of chronic obstructive pulmonary disease (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" [1].

According to guidelines, COPD should be suspected in any patient aged 40 years or more with symptoms of cough, sputum production, or breathlessness and/or a history of exposure to risk factors, in particular smoking [2, 3]. Smoking is well known for causing COPD but the list of risk factors for developing COPD is long and include both host factors and environmental exposures, most often interacting [4, 5]. This should especially be taken into account outside Europe and the USA where exposure to risk factor other than smoking seems to play a larger role. A list of the currently accepted and suggested risk factors is shown in Table 1; risk factors marked with an asterisk have the most literature supporting their role.

Guidelines usually state that a suspected diagnosis of COPD is confirmed by spirometry with the well-known – but perhaps still questioned – post-bronchodilator ratio (FEV_1/FVC) of <0.7. There are, however, a number of differential diagnosis that need to be taken into account, as listed in Table 2.

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Table 1 Risk factors for chronic obstructive pulmonary disease (COPD)*.

External
Smoking*
Socioeconomic status*
Occupation*
Biomass fuel exposure*
Internal
Genetic factors*
Gender
Chronic mucus hypersecretion
Other
Airway hyper-responsiveness*
Elevated IgE
Asthma*
Environmental pollution
Perinatal events and childhood respiratory illness
Recurrent bronchopulmonary infections
Diet

IgE immunoglobulin E
In an attempted descending order, *risk factors with strongest evidence to support

Table 2 Most important differential diagnoses to chronic obstructive pulmonary disease (COPD).

Respiratory
Chronis asthma
Bronchiectasis
Obliterative bronchiolitis
Diffuse panbronchiolitis
Tuberculosis
Non-respiratory
Congestive heart failure
Recurrent pulmonary embolism

The most difficult clinical problem will often be distinguishing COPD from persistent poorly reversible asthma, especially in older patients. In general, it is easy to distinguish asthma from COPD, in particular in young and middle-aged patients where history will often suffice and where demonstration of a significant bronchodilator response is diagnostic of asthma. However, in older patients with significant previous cigarette exposure and only modest reversibility to a bronchodilator, the diagnosis can be difficult. In specialist clinics, measurements of NO in exhaled air, cell differentials and mediators in induced sputum, and typical features such as fragmented surface epithelium, presence of eosinophils and thickened basement membrane in mucosal biopsies can all be used, but most often a more pragmatic approach is needed. Treatment response to inhaled corticosteroids will often be the indicator of the presence of asthma or COPD to the clinician but the evaluation by treatment has never really been examined properly in prospective studies.

For most of the other differential diagnoses, the combination of a good clinical assessment together with simple investigations will usually resolve any uncertainty; often a chest radiograph will be helpful.

In the middle-aged and elderly, congestive heart failure is an important differential diagnosis. In many text books, fine basilar inspiratory crackles on auscultation is referred to as a good sign of heart failure but often minor abnormalities can be found in COPD as well. In this case, a chest radiograph is often helpful showing a dilated heart and flow shift indicating heart failure. Spirometry will more often show volume restriction than airflow restriction but particularly in more severe cases airflow limitation secondary to heart failure can be seen.

A diagnosis of bronchiectasis is often helped by a history of large volumes of sputum. It can sometimes be seen on a plain chest radiograph but often a diagnostic high-resolution computed tomography (HRCT) scan is required for diagnosis. Caution in interpreting bronchiectasis on an HRCT scan as absence of regular COPD is warranted as the two diseases often coexist.

Tuberculosis is an important differential diagnosis in high-prevalence countries and a chest radiograph is important. Obstructive bronchiolitis is seen much less frequently than COPD, is more frequent in younger patients and is often associated with rheumatoid arthritis or extensive fume exposure but smoking may be causative as well. An HRCT scan, preferably with expiration scans, is needed. Diffuse panbronchiolitis is rare and not smoking-related; HRCT is needed for diagnosis.

When differential diagnoses have been excluded, a post-bronchodilator FEV_1/FVC ratio <0.7 confirms the diagnosis of COPD. Again, caution is required when using this fixed cut-off value. The normal value for the FEV_1/FVC ratio is age-dependent and whereas a ratio <0.7 is clearly abnormal in a 40-year old it is close to the expected value for an 80-year old. Thus, COPD is likely to be under-diagnosed in younger adults and "over-diagnosed" in the elderly; whether this is truly over-diagnosis or actually abnormality associated with excess risk (like arterial hypertension associated with age) is currently unknown. If spirometry is requested on the basis of breathlessness this dilemma is usually trivial. However, an increasing number of more affluent patients are being diagnosed in health programmes or as a result of screening and have no symptoms. In this case, liberal use of the diagnostic label of COPD is unlikely to be very helpful in those with borderline abnormal spirometry.

Once a diagnosis of COPD is established it is recommended that staging takes place. According to guidelines, classification of the severity of the disease is based on FEV_1 expressed in per cent of predicted value as shown in Table 3. In addition to problems arising from the use of different reference values, or lack of locally derived reference values in certain ethnic population groups, it is well-known that composite scores including lung function, symptoms, body weight and exercise tolerance have better

Table 3 Severity grading of chronic obstructive pulmonary disease (COPD) according to GOLD [1].

Stage I:	Mild $FEV_1/FVC < 0.70$	$FEV_1 \geq 80\%$ predicted
Stage II:	Moderate $FEV_1/FVC < 0.70$	$50\% \leq FEV_1 < 80\%$ predicted
Stage III:	Severe $FEV_1/FVC < 0.70$	$30\% \leq FEV_1 < 50\%$ predicted
Stage IV:	Very severe $FEV_1/FVC < 0.70$	$FEV_1 < 30\%$ predicted or $FEV_1 < 50\%$ predicted plus chronic respiratory failure

predictive value than FEV_1 alone; a good example of such a score is the BODE index [6]. If such a score is not used in its suggested form, several of the variables should nevertheless be registered, see later.

Symptoms in COPD

The most common symptoms seen in COPD are breathlessness, cough and fatigue. There is no good correlation between lung function and symptoms of COPD, not even the standardized scoring of breathlessness correlates well with FEV_1; the important message being that a simple physiological measure can never substitute a symptom history.

Breathlessness

Breathlessness is the most significant symptom in COPD and it is associated with significant disability, poor quality-of-life and poor prognosis.

Although the degree of breathlessness in a single patient can be difficult to understand – let alone explain, properly – we understand a lot about the mechanisms underlying the sensation of breathlessness in COPD [7]. Breathlessness is defined as an awareness of increased or inappropriate respiratory effort and is assumed to relate to an awareness of the motor command to breathe. The terms used to describe breathlessness may vary with the stimulus used to provoke it and despite the increased time for expiration many COPD patients describe the sensation of breathlessness as one of inspiratory difficulty [8]. The intensity of breathlessness is best related to changes in end-expiratory lung volumes during exercise and this fact probably explains the need to look at changes in measurements other than FEV_1 and FVC for characterizing COPD patients' disability or for assessing effects of treatment. For this purpose, measurements of inspiratory capacity (IC) may be better suited (see Chap. 3).

In early stages of COPD, patients often modify their behaviour in order to cope with the sensation of breathlessness. Patients avoid climbing stairs, get help with cleaning and shopping, and to the author it has always been a mystery how otherwise well-functioning subjects can ascribe increasing breathlessness associated with ordinary tasks as being merely the results of "age." However, with increasing severity of COPD, breathlessness becomes an unavoidable symptom and in severe and very severe COPD there is rarely any time when patients are asymptomatic. In very severe COPD, the patient is usually breathless on minimal exertion but due to the poor correlation between FEV_1 and breathlessness some patients may have surprisingly high levels of activity, even in late-stage COPD.

The degree of breathlessness can be measured using a number of different scales and questionnaires. The simple MRC dyspnoea scale [9] is a useful tool but as it was originally developed for assessing breathlessness in epidemiological surveys in the workplace, it is relatively insensitive to changes. However, a slightly modified version of the MRC Questionnaire, as shown in Table 4, has been translated into numerous languages, is easy and quick to use and it relates well to measures of health status and has additional predictive value to that of FEV_1 when it comes to predicting resource utilization and mortality [10].

The baseline and transitional dyspnoea indices of Mahler et al. [11] are much more specific and more susceptible to change but in addition they are much more time-consuming to use for clinicians; its main role lies in evaluating interventions with a supposed effect on breathlessness. The Borg category scale, as shown in Table 5, is

Table 4 The Medical Research Council dyspnoea scale (Modified).

Grade	Description
0	Not troubled with breathlessness except with strenuous exercise
1	Troubled by shortness of breath when hurrying or walking up a slight hill
2	Walks slower than people of the same age due to breathlessness or has to stop for breath when walking at own pace on the level
3	Stops for breath after walking 100 m or after a few minutes on the level
4	Too breathless to leave the house or breathless when dressing or undressing

Table 5 The Borg scale.

0 Nothing at all
0.5 Very, very slight (just noticeable)
1 Very slight
2 Slight (light)
3 Moderate
4 Somewhat severe
5 Severe (heavy)
6
7 Very severe
8
9
10 Very, very severe (almost maximal)
Maximal

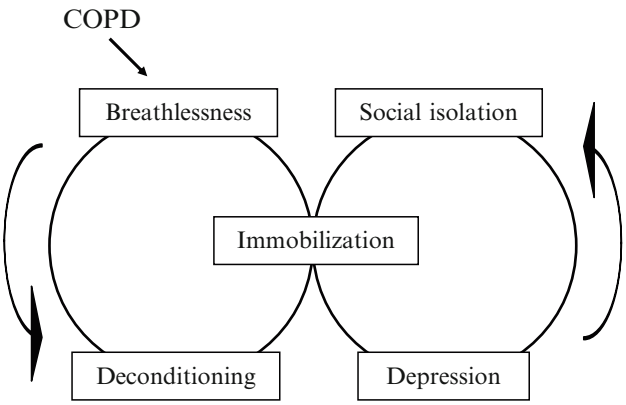

Fig. 1. The impact of breathlessness in chronic obstructive pulmonary disease (*COPD*)

often used in the exercise laboratory as it measures short-term changes in perceived intensity during a particular task, e.g., during shuttle walk testing. It is simple and easy to explain. As an alternative, visual analogue scales can be used; however, like the Borg scale, this approach is for use in task-specific situations and cannot be used for assessing the degree of breathlessness associated with usual daily tasks.

Although there is an increasing focus on systemic manifestations of COPD (see later), breathlessness is a major cause of deconditioning and subsequent muscle wasting in COPD. This has profound effects on the life of COPD patients as illustrated in Fig. 1.

Cough and Sputum Production

Cough is a respiratory defence mechanism protecting the airways and cough is the major method of clearing excess mucus production [12]. In COPD patients, cough as a symptom is almost as common as breathlessness and may actually precede the onset of breathlessness [8]. Cough is usually worse in the morning but seldom disturbs the patient's sleep; it can, nevertheless, be disabling because of the embarrassment felt by many patients when they have bursts of productive cough on social occasions and may contribute to the isolation often imposed on patients due to breathlessness (see Fig. 1). The actual role of cough and phlegm on the natural history of COPD has been debated for decades. Currently, most epidemiological studies seem to show that the symptoms of chronic bronchitis do not increase the risk of developing COPD in smokers with normal lung function [13]. However, the presence of these same symptoms in patients with severe and very severe COPD predict both a more rapid decline in lung function and more frequent acute exacerbations of COPD [14, 15].

In patients with more severe COPD, cough syncopy is frequent. It arises from the acute increase in intrathoracic pressure during cough, producing a transient reduction in venous return and cardiac output. A similar mechanism is thought to be the explanation for cough fractures.

Cough is difficult to measure. Questionnaires exist but their validity is questionable and devices for direct measurement of cough are still in the development stage.

Wheezing

Wheezing is generally seen as an asthma symptom but frequently occurs in COPD as well. However, nocturnal wheeze is uncommon in COPD and suggests the presence of asthma and/or heart failure [2, 3].

Fatigue

Fatigue is frequently reported by COPD patients. It is a ubiquitous and multifactorial symptom not to be confused with simple physical exhaustion due to breathlessness but is more an awareness of a decreased capacity for physical and mental activity due to lack of resources needed to perform the activity in question. Fatigue has been identified as a serious consequence in a number of chronic conditions and will undoubtedly be a focus of attention in the future characterization of COPD. No standardized measurement scales for fatigue in COPD exist.

Other Symptoms

Chest pain is a common complaint in COPD, mostly secondary to muscle pain. However, it should be noted that ischaemic heart disease is frequent in any population of heavy smokers and COPD patients may be at particular risk. Acid reflux occurrence is also frequent in COPD.

Ankle swelling may result from immobility secondary to breathlessness or as a result of right heart failure. Anorexia and weight loss often occur as the disease advances and should be mirrored by measurements of body mass index (BMI) and body composition (see later). Psychiatric morbidity is high in COPD, reflecting the social isolation, the neurological effects of hypoxaemia and possibly the effects of systemic inflammation; this is described in more detail in Chap. 17. Sleep quality is impaired in advanced disease [16] and this may contribute to neuropsychiatric comorbidity.

Assessment of the Patient Suspected of COPD

History

An accurate history, not least for the purpose of excluding differential diagnoses, should include family history of heart and lung diseases, childhood diseases (atopic and infectious), environment in which the subject grew up including exposures to fumes gas and dust, education and occupational experiences.

Most patients are, or have been, smokers with cigarette smoking dominating. Depending on the environment, patients may underestimate their tobacco use when confronted with questions on life-time smoking habits. Calculation of pack-years of smoking provides a useful estimate of smoking intensity (1 pack-year is equivalent to 20 cigarettes smoked per day for 1 year – or ten cigarettes smoked per day for 2 years) but additional information is needed on debut of smoking and inhalation habits. Objective verification of smoking status can be helpful and is often used in smoking cessation programmes, most often using exhaled breath carbon monoxide or urinary nicotine measurement.

Occupational exposures to organic dust and fumes contribute to the accelerated decline in the lung function characteristic of COPD [4, 5]. The evidence for outdoor as well as indoor pollution is much weaker except for areas where indoor burning of biomass fuel has lead to more extensive exposure.

Finally, a social history is needed in most COPD patients. Often the carer for the patient will have the same age and possibly other chronic diseases and the need for social support may depend on this. Also, the smoking habits of the family may determine the outcome of smoking cessation intervention.

Physical Signs

Not surprisingly, it is difficult to come up with standardized guidance for a disease that spans from almost normal health to terminal disease. The physical signs in patients with COPD will invariably depend on the severity of disease. A physical examination will in general be a poor tool for detecting mild or moderate COPD, and the reproducibility of physical signs have been shown to be very variable. In contrast, physical signs are more specific and sensitive for severe COPD.

Patients with mild and moderate disease appear normal in clinic and usually have done little to reduce their normal daily activities. Patients with severe COPD, and indeed very severe COPD, will appear breathless just from entering the clinic room, and even a short history will often be sufficient to realize that they are distressed. These patients will often appear to have a “barrel chest.” This used to be ascribed to emphysema, but more likely it represents the visible component of hyperinflation, where patients, in order to meet the ventilatory demands, increase their end-expiratory lung volume. Patients will often sit leaning forward with their arms resting on a table in front of them or on some other stationary object in order to use the ribcage and larger muscles to function as inspiratory muscles. Often, these patients often use pursed-lips breathing, presumably to avoid small airways collapse during tidal breathing.

The general stature of the patients should be observed. Weight loss, especially when there is clear muscle atrophy, can be a sign of severe disease, emphysematous-type COPD and likely a systemic effect of COPD, possibly due to systemic inflammation.

The patient’s breathing should also be observed. Use of accessory muscles indicates severe disease. Percussion of the chest is of little, if any, use in patients with COPD.

A tympanic percussion note is not specific for pulmonary hyperinflation and it is dubious if clinicians can use percussion for estimation of diaphragmatic motion.

On auscultation, patients with COPD generally have a noisy chest although patients with significant emphysema in a stable state can have remarkably few chest sounds. Although significant research has been carried out on chest sounds, it is unclear to this author if it should have any impact on the daily management of patients with COPD where the value of auscultation is generally limited – except in cases where comorbidities or complications may be detected this way; e.g., as unilateral wheeze in cases of endobronchial tumour, or decreased chest sounds on one side due to pneumothorax. Auscultation of the heart is an essential part in the physical examination of COPD patients. Severe COPD is associated with tachycardia at rest and with increasing severity of disease the risk of atrial fibrillation increases. Ventricular gallop rhythm, increases in the pulmonary second heart sound and murmurs of pulmonary or tricuspid insufficiency can all be signs of cor pulmonale.

A raised JVP, hepatomegaly and peripheral oedema have all been considered as signs of pulmonary hypertension and cor pulmonale. However, these signs are not specific for cor pulmonale as a raised JVP may result from increased intrathoracic pressure secondary to dynamic hyperinflation and hepatomegaly may be illusive due to downward displacement of the liver by the diaphragm in the hyperinflated chest. Finally, peripheral oedema can be the result of both altered renal function as a result of hypoxaemia and the result of simple inactivity.

Body Habitus

Weight, or rather BMI, has been shown to be a very strong predictor of prognosis with rapidly increasing risk of dying when BMI falls, even within the normal range [17, 18]. Some studies indicate that measures of fat-free mass can add further information [19]; the easiest and cheapest way of measuring body composition is by using measurements of body impedance. Measures of skin-fold thickness or mid-thigh diameter may also be useful but currently these methodologies have not been validated to the extent of body impedance. A BMI <20 kg/m^2 will denote a subject at risk as will a fat-free mass index <15 kg/m^2 in women and <17 kg/m^2 in men.

Lung Function Tests

The role of lung function tests COPD is crucial for diagnosis, assessment of severity, prognosis and for monitoring the course of the disease. The physiologic assessment of the COPD patient is described in detail in Chap. 3.

Arterial Blood Gases

In stable state, there is a general relationship between reductions in FEV_1 and arterial oxygen tension (P_aO_2), whereas arterial carbon dioxide tension (P_aCO_2) usually remains within the normal range until FEV_1 falls below 1.0–1.2 l (<30% of predicted) and even then large variations are found. Measurement of arterial blood gases with the patient breathing room air is recommended for assessing patients with moderate or severe COPD. Often, a practical approach is to initially measure arterial oxygen saturation ($SatO_2$) by means of pulse oximetry. If $SatO_2$ is <92%, arterial gases should be measured.

Exercise Testing

Exercise capacity can be assessed in different ways, but outside the physiology laboratorium; either a 6 min walk test or incremental shuttle walk testing is used. The correlation between lung function and exercise capacity is poor in the individual patient but in groups there are clear correlations, particularly with measures that reflect hyperinflation such as IC. As mentioned earlier, breathlessness during exercise can be measured easily using either a Borg scale (Table 5) or a visual analogue scale. During exercise, the severity of breathlessness is closely related to ventilation and to the severity of dynamic hyperinflation. Many, but not all, patients will desaturate during exercise and the extent of arterial desaturation is related to both TL_{CO} and resting blood gases.

Assessing exercise capacity is of particular value in patients whose breathlessness appears to be out of proportion to simple spirometric measures; it can also provide information of value for assessing cardiac disease through aligning the exercise test with a cardiac exercise test used for assessing ischaemic heart disease. Exercise testing is also usually done before and after pulmonary rehabilitation and is increasingly being used to assess the value of other interventions, including pharmacological treatments, see Chap. 3. In parallel with exercise testing, tests of muscle strength may be applied. Simple measures, e.g., quadriceps muscle strength, have been shown to be of value in COPD [20].

Blood Tests

Blood tests are often of little use in COPD but can be used for identifying polycythaemia in patients with severe COPD as this is associated with risk of subsequent vascular events, and there is some evidence to suggest that venesection may improve exercise tolerance as well as mental capacity. As in other chronic diseases, anaemia can occur as a systemic consequence and is generally a marker of poor prognosis; anaemia associated with COPD is usually normochromic and normocytic, characteristic of the anaemia of chronic disease. There is no indication for assessing blood biochemistry routinely in COPD patients and although there is a growing research interest in markers of systemic inflammation in COPD, data so far available are difficult to implement in clinical practice.

α_1-Antitrypsin levels should be measured in all patients aged <50 years, and in those with a family history of emphysema at an early age.

Radiology

There are no specific features of COPD on a plain chest radiograph. A radiological diagnosis of "emphysema" on a plain chest radiograph is usually based on lung overinflation and should be reported as such. Overinflation of the lungs results in low diaphragms, an increase in the retrosternal airspace and an obtuse costophrenic angle on the postero-anterior or lateral chest radiograph. The vascular changes associated with emphysema can often be seen on a plain chest radiograph by a reduction in the size and number of pulmonary vessels, particularly at the periphery of the lung, vessel distortion and areas of transradiancy; however, assessment of vascular loss in emphysema is very dependent on the quality of the radiograph.

Computed tomography (CT) can be used for the detection and quantification of emphysema, either using semiquantitative visual assessment of low-density areas on the CT scan or by using measures of lung density to quantify areas of low x-ray attenuation. Several studies have shown that visual evaluation of the CT scan can locate areas

of macroscopic emphysema in post mortem or resected lungs. The use of HRCT with thin slices does not improve the detection of mild emphysema; however, HRCT can be used to distinguish between the various types of emphysema.

More quantitative approaches to assessing macroscopic emphysema have been employed [21, 22]. They use the original virtue of the CT-scanner as a densitometer. As emphysema develops, alveolar wall mass decreases and this leads to a decreased CT lung density. Initial experiences suggest that this can be used to measure progression of emphysema, although the radiation involved precludes its use as a frequent measure of disease progression.

Magnetic resonance (MR) scanning using hyperpolarised gases such as Helium is still in its pioneering phase.

Electrocardiography and Echocardiography

Routine electrocardiography is not required in the assessment of patients with COPD unless cardiac comorbidities are suspected, including atrial fibrillation. ECG is an insensitive technique in the diagnosis of cor pulmonale.

Echocardiography can be used to assess the right ventricle and for the detection of pulmonary hypertension. In addition, it provides an opportunity to check for cardiac comorbidity, particularly in patients with breathlessness out of proportion to the findings on general examination and from pulmonary function testing.

Assessment of the Patient with Acute Exacerbation of COPD

This issue is dealt with in detail in Chap. 12 and has been reviewed recently [23].

Summary

COPD should be suspected in any patient aged 40 years or more with symptoms of cough, sputum production, or breathlessness and/or a history of exposure to risk factors, in particular smoking. Spirometry is needed for both diagnosis and staging, although other parameters such as breathlessness, exercise tolerance and body mass and/or body composition should be included in the staging procedure.

In the assessment of patients suspected of COPD, several differential diagnoses should be considered. Assessment can usually be done using fairly simple clinical tools, although advanced imaging seems to be a promising tool for the near future.

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