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When to use and not to use spirometry in patients admitted to the internal medicine wards for the diagnosis of chronic obstructive pulmonary disease

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ABSTRACT

Chronic obstructive pulmonary disease (COPD) is one of the main causes for admission to an internal medicine ward, due to exacerbations of the disease itself or to comorbidities leading to dyspnea as an intriguing symptom. In many cases, a diagnosis of COPD is made only on clinical grounds, but well-accepted guidelines strongly suggest measuring the lung function to diagnose and stage such a common disease. Problems with the equipment, its use and data interpretation lead to underuse spirometry in general and in patients in internal medicine in particular.

Toward a sustainable and wise medicine

The prevalence of chronic obstructive pulmonary disease (COPD) in patients over 65 is 6-15% in women and 7-34% in men.[1] The variability of these figures is probably due to the under- or misdiagnosis of respiratory diseases. One of the major causes for this is the limited use of spirometry in this population.

Among patients, mainly older patients admitted to internal medicine wards, respiratory symptoms and reduced mobility are highly prevalent and associated with important adverse outcomes. In this setting, the underlying mechanisms are likely to be a consequence of cumulative life-long exposures to tobacco smoke, air pollutants, and occupational dusts, in addition to respiratory infections.

Respiratory impairment can typically be detected with a spirometric measurement of pulmonary function, which can be subsequently classified as airflow limitation (*e.g.*, chronic obstructive pulmonary disease or asthma) or restrictive pattern (*e.g.*, interstitial lung disease or heart failure). The criteria that define airflow limitation and restrictive pattern are based on the diagnostic thresholds published by the Global Initiative for Obstructive Lung Disease (GOLD).[2]

Patients affected by COPD are frequently admitted to internal medicine wards because of exacerbations of the disease itself or comorbidities leading to dyspnea as an intriguing symptom. Only patients with very severe exacerbations requiring invasive or non-invasive ventilation (NIV) are admitted directly to intensive care units or pulmonology departments. Depending on the hospital setting, patients who need NIV could also be admitted to internal medicine units.

Some doctors rely only on symptoms such as wheezing, shortness of breath, and coughing, with or without phlegm, to diagnose COPD. However, they could underestimate these symptoms, assuming that they reflect a mild problem, when actually they indicate a COPD.

Breathlessness for example may be due to heart diseases, diaphragm weakness, pulmonary vascular disease or systemic disorders, such as anemia, obesity or hyperthyroidism. But those symptoms can also stem from a common cold, bronchitis, pneumonia, or other common conditions.[1,2]

The failure to use spirometry, a powerful diagnostic tool, may lead to both misdiagnosis and under diagnosis of this condition.[3] In spite of the importance of spirometry, studies from a number of countries indicate that it is frequently underused in both hospital and primary care settings.[4-8]

A study at Johns Hopkins Hospital showed that airway obstruction is seriously under-diagnosed in hospitalized patients, not only at the time of admission, but it tends to remain undiagnosed and therefore

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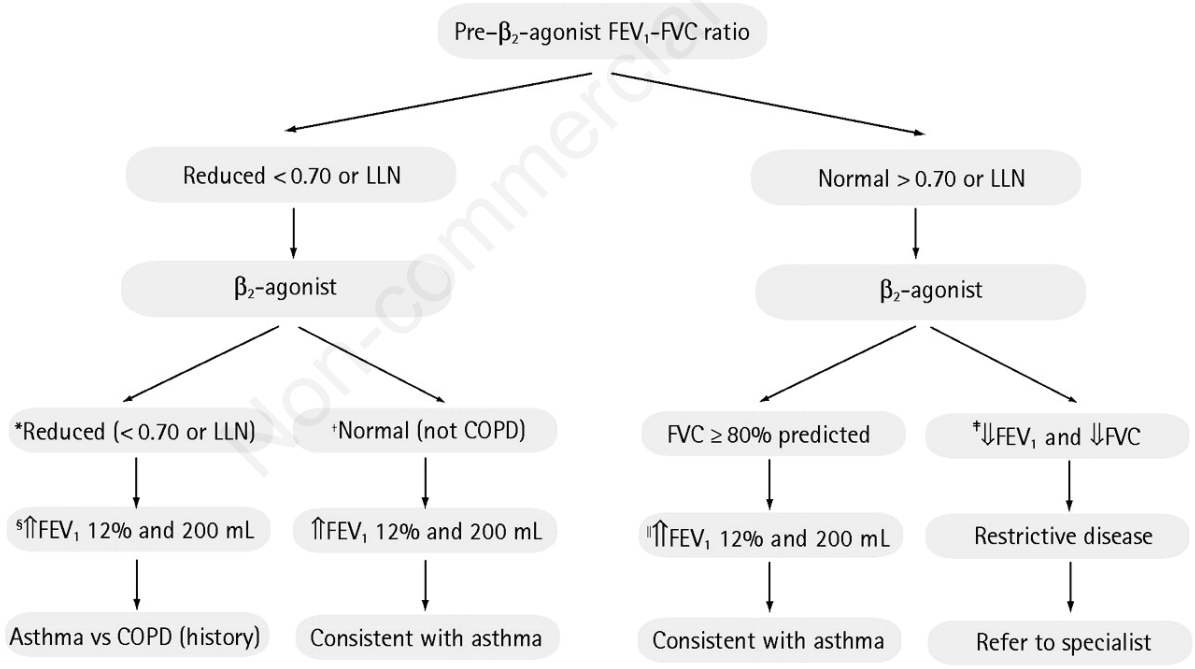
untreated also at the time of discharge.[6] The authors concluded that routine spirometry would reduce this problem.[6] A study on patients with cardiovascular disorders in Italy reached similar results.[9]

Therefore, despite a wealth of evidence supporting the value of spirometry as a diagnostic and staging tool, and the enthusiasm with which its use is promoted in the guidelines,[10] there is a clear mismatch between recommendations and practices. The factors evoked to explain this situation are lack of time and inadequate staff training.[11] In fact any healthcare professional who wishes to use spirometry should be trained both to perform the test and to interpret the results[12] (Figure 1).[13] Also a lack of confidence may contribute to its underuse[14,15] together with the use of poorly designed and unduly complex spirometers, which offer too many confusing parameters of limited value, and, last but not least, the lack of availability of spirometers in many internal medicine wards, therefore the exam is performed by pneumology units.

Furthermore, it is commonly believed that in elderly patients spirometry cannot be performed properly. Additionally, elderly patients often have concomitant diseases with similar clinical symptoms, that may complicate the diagnosis. As a consequence, the majority of studies on spirometry in an adult population included only a small number of elderly subjects, and the specific characteristics of the elderly that may influence functional measurements and their interpretation were not factored in. The skills of the operator play an important role in obtaining an acceptable spirometry, but it is even more important to apply international criteria to give instructions that can be readily understood by patients with sensory and cognitive limitations, and to allow the maneuvers to be repeated after a suitable interval at rest.[16] As a matter of fact, it is well known that to validate spirometric results, at least three acceptable spirograms must be obtained. In each test, patients should exhale for at least six seconds and stop when there is no volume change for one second. The test session ends when the difference between the two highest values of the forced vital capacity (FVC) and the two highest values of the largest forced expiratory volume in 1 s (FEV1)



COPD—chronic obstructive pulmonary disease, FEV_1—maximal volume of air exhaled after a maximal inhalation in the first second of a forced exhalation, FVC—maximal volume of air exhaled after inhalation during forced exhalation, LLN—lower limit of normal.
*FVC <80% predicted—perform full pulmonary function tests to rule out hyperinflation vs combined obstructive and restrictive defect.
†FVC ≥80% predicted.
‡FEV_1 and FVC < 80% predicted.
§The % change is calculated as $\frac{FEV_1 \text{ postbronchodilator} - FEV_1 \text{ prebronchodilator}}{FEV_1 \text{ prebronchodilator}}$; FEV_1 might not improve after β_2-agonist challenge.
‖Lack of change in FEV_1 is not diagnostic; referral for methacholine challenge recommended.

Figure 1. From *New spirometry interpretation algorhytm.* *Reproduced from D'Urzo* et al., *2011,*[13] with permission of the CFP/MFC (http://www.cfp.ca/content/57/10/1148.long).

is within 0.2 L. If both criteria are not met after three maneuvers, the test should not be interpreted. The test should be repeated until the criteria are met or until eight tests have been performed.[17,18]

A reduced FEV1 and absolute FEV1/FVC ratio indicate an obstructive ventilatory pattern, and a bronchodilator challenge testing is recommended to detect patients with reversible airway obstruction (*e.g.*, asthma). A bronchodilator is given, and spirometry is repeated after several minutes. The test is positive if FEV1 increases by at least 12% and FVC increases by at least 200 mL. The patient should not use any bronchodilator for at least 48 h before the test. A negative bronchodilator response does not completely exclude the diagnosis of asthma. The forced expiratory flow 25-75% (FEF 25-75%) or mid-expiratory flow rate is the average forced expiratory flow rate over the middle 50% of the FVC. It can help in the diagnosis of an obstructive ventilatory pattern, as in the case of COPD. Because it is dependent on FVC, the FEF 25-75% is highly variable. In the correct clinical situation, a reduction in FEF 25-75% of less than 60% of the predicted value and an FEV1/FVC ratio in the low to normal range may confirm airway obstruction.[19]

The maximal voluntary ventilation (MVV) maneuver has been largely superseded by FEV1, and can offer a little additional contribution in the clinical setting. However, it may be useful in the conditions where the ventilatory capacity may be impaired by mechanisms that are different from those affecting FEV1, therefore it can help us differentiate between obstructive and restrictive conditions. The patient is instructed to breathe as hard and fast as possible for 12 s. The result is extrapolated to 60 s and reported in liters per minute. In general, MVV is approximately equal to the FEV1 X 40. A low MVV can occur in obstructive disease, but it is more common in restrictive conditions. If the MVV is low, but FEV1 and FVC are normal, then poor patient effort, a neuromuscular disorder, or major airway lesion must be considered.

Milne and Williamson observed that the percentage of elderly women who were unable to perform spirometry increased with age and was correlated with a diagnosis of dementia.[20] This was confirmed later by Sherman *et al.*,[21] who reported that the subjects unable to perform spirometry had the lowest psycho-motor test scores. The SARA (*salute respiratoria nell'anziano*; respiratory health in the elderly) study found that cognitive impairment, a shorter 6-min walking distance (used to assess the functional status) and a lower educational level were independent risk factors for a poorer acceptability rate. The SARA study also found that age and male gender were risk factors for a less reproducible FEV1,[22] showing that age *per se* does not influence spirometric performance, but it matches with cognitive and functional impairment. Contraindications to this exam are the same for young and old people (Table 1).[23]

Conclusions

In conclusion, we found that spirometry is the first (not in terms of timing but of importance) and single test to perform on many patients admitted to the internal medicine unit. In some cases anyway it is necessary to go further with the assessment of lung function, therefore we need to collaborate with a consultant pneumologist, in order to perform more diagnostic tests, such as full lung volumes, diffusing capacity, and bronchial provocation testing, when recommended.

Not all potential users accept the value of spirometry as a tool which will impact on practice or patient management[24] and, since COPD is largely a condition of smokers, it has been reported that some physicians fail to use spirometry since they believe that little or nothing can be done to help patients who keep on smoking.[25,26]

On the other hand, screening for COPD with spirometry is useless and time- and money-consuming,[27] so we have to avoid it in people who have only history of smoking and lack of respiratory symptoms.

Table 1. From *An approach to interpreting spirometry*.

Contraindications to use of spirometry
Aneurysms of the thoracic aorta (increased thoracic pressure may cause rupture)
Unknown origin hemoptysis (underlying condition may be aggravated by FVC maneuver)
Pneumothorax
Recent abdominal or thoracic surgery
Recent eye surgery (intraocular pressure may increase during spirometry)
Unstable angina or recent myocardial infarction
Vomiting or severe vertigo

FVC, forced vital capacity. *Modified from Barreiro and Perrillo, 2004.*[23]

Take home message

Spirometry is a tool to be used if COPD is suspected on history and clinical grounds in patients with dyspnea.

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