Obstructive? Restrictive? Or a Ventilatory Impairment?

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Since 1991, the guidelines for interpretation of lung function tests endorsed by the American Thoracic Society (ATS) have recommended that the presence of airflow obstruction be determined by a reduction in the ratio of FEV₁ to FVC (or vital capacity), but that the severity of the obstructive impairment be indicated by the reduction in FEV₁ itself, expressed as a percent of its predicted value (FEV₁ % predicted). [1] Both of these choices have a good rationale and were again recommended in the 2005 ATS/European Respiratory Society joint guidelines. [2] The FEV₁/FVC ratio has an inherent correction for the variance in FVC, which contributes to that of FEV₁, so the normal range for the ratio is tighter than for FEV₁, increasing its sensitivity for the recognition of abnormal airflow. The recommended National Health and Nutrition Examination Survey III reference data [3] show that the normal FEV₁/FVC ratio decreases from about 0.85 at age 20 years to 0.75 at age 70 years, and the lower limit of normal (LLN), representing the fifth percentile of a healthy nonsmoking reference population of the same age, is almost exactly 0.10 below the predicted value throughout this age range. For the FEV₁, the fifth percentile LLN ranges from 17% to 25% below the predicted value over this age range. The FEV₁/FVC ratio decreases steadily with the early progression of disease, but varies more with advanced disease. If FVC is maintained, the ratio continues to fall, but as air trapping reduces the FVC, along with further reduction in FEV₁, the decrement in the ratio of the two is blunted. For example, a patient with FEV₁ of 1 L and FVC of 2 L is clearly more advanced than one of the same age and size with an FEV₁ of 1.8 L and FVC of 3.6 L, but both have an FEV₁/FVC of 0.50. Thus, the FEV₁ % predicted more reliably tracks the advancing severity of disease and correlates, albeit not tightly, with increasing symptoms, disability, and morbid outcomes. [4] , [5]

The interpreter of spirometry is guided to first look at the FEV₁/FVC ratio to see if airflow obstruction is present, then look at the FEV₁ % predicted to judge its severity. This works well when the FVC is normal and only obstruction is present and also remains accurate when the FVC is reduced by air trapping. When both the FEV₁/FVC and FVC are reduced, it is recommended that lung volume measurement be obtained; if the total lung capacity (TLC) is normal and the residual volume (RV) increased, the process is obstructive, but when the TLC is reduced both obstruction and restriction are present. Although it is intuitively clear that any reduction in lung volume due to a restrictive process will add to the observed decrement in FEV₁, the guidelines do not explicitly discuss this caveat or offer any suggestion for separately assessing the components of a mixed disorder. Because of this, it is a common experience to see reports of “severe airflow obstruction” when it is likely that much of the decrement reflects a concomitant restrictive process.

In this issue of CHEST (see page 598), Gardner and colleagues [6] offer a helpful suggestion to more appropriately assess the severity of
obstruction when TLC measurement shows that restriction is also present. They reason that when obstruction is absent FEV₁ is likely to be decreased in proportion to the reduction in TLC, so they propose dividing the FEV₁ % predicted by the observed TLC % predicted to create an adjusted FEV₁ % predicted. The adjusted value is then used to determine the severity of obstruction in accordance with whichever schema of categories is used. Acknowledging that the increased recoil forces of a parenchymal restrictive process may alter the relationship of FEV₁ and TLC, this simple adjustment should greatly improve the attribution of severity to the obstructive component. In support of this, they show that the adjusted FEV₁ % predicted correlates better than the unadjusted value with another index of airflow obstruction, the RV/TLC ratio. They also find that the grades of severity of obstruction in a nonselected group of patients with mixed obstructive-restrictive impairments are more evenly distributed by the adjusted FEV₁ % predicted but highly skewed to the severe end when the unadjusted value is used.

Although it is certainly appropriate to try to define the separate contributions to the observed physiologic abnormalities, we should not lose sight of the overall impairment suffered by the patient. The 2005 ATS/European Respiratory Society guidelines for interpretation extended the use of the FEV₁ % predicted from relating only to obstruction to recommending it as the index of “severity of any spirometric abnormality.”[2] This reflects the idea that the ventilatory impact of an obstructive, restrictive, or mixed disorder can be related to the decrement in FEV₁. A patient whose adjusted FEV₁ % predicted shows mild obstruction and who also has moderate restriction may have an FEV₁<50% predicted. This can be characterized as a “severe ventilatory impairment” due to the combined abnormalities to better capture the overall impact on the patient.

The adjustment to the FEV₁ % predicted requires the TLC value, so it is of no aid to the interpreter when only spirometry data are available. This will commonly be the case in the office or clinic and is often the case in the pulmonary function laboratory as well, if the orders do not provide flexibility to do lung volume measurement. Airflow obstruction can be readily identified from the FEV₁/FVC ratio, but when the FVC is also low, it is uncertain whether this is due to an increased RV or a decreased TLC. As airflow obstructive diseases are far more common than restrictive diseases in a general population, most will have only obstruction, with greater confidence when the FEV₁/FVC ratio is <0.55 or the FVC is >85% predicted. When the low FEV₁/FVC ratio is nearer the LLN and the FVC is more markedly reduced, then the likelihood of a concomitant restrictive process is increased. [7] , [8] ; [9] Again, rather than attributing the entire decrement in FEV₁ to airflow obstruction, the combination of a low FEV₁/FVC and low FVC can be characterized based upon the (unadjusted) FEV₁ % predicted as a (mild, moderate, severe) ventilatory impairment due to airflow obstruction and (possible, probable) restriction with advice for further testing as appropriate. This somewhat generic phrasing may also be useful when the patient's FEV₁/FVC ratio is normal but the FVC and FEV₁ are both decreased, as many of these individuals will prove to have a normal TLC.[10] Persons with this nonspecific pattern do not have normal spirometry but do not meet the criteria for either obstruction or restriction[11]; they can be described as having a ventilatory impairment based on the reduction in FEV₁.

Airflow obstruction is the most frequent abnormal finding on spirometry or full lung function testing. Current common practices can overestimate its prevalence or severity, but simple solutions are at hand. It has been well established that the use of a fixed FEV₁/FVC ratio of 0.70 will misclassify many older adults, [12] . [13] , [14] as the evidence-based fifth percentile LLN is 0.67 at age 60 years and 0.63 at age 80 years. To much more accurately determine the LLN, one need only subtract 0.10 (or 10%) from the FEV₁/FVC ratio predicted by the reference data. When a patient with airflow obstruction is also shown to have a low TLC by lung volume measurement, the decrement in FEV₁ will reflect both abnormalities. The easily calculated adjustment to the FEV₁ % predicted proposed by Gardner and colleagues [6] in this issue will allow the severity of the obstructive component to be more accurately reported. When only spirometry is available, there will often be uncertainty regarding the presence and contribution of restriction. In such cases, describing the decrement in FEV₁ % predicted as a ventilatory impairment, rather than attributing it only to obstruction, will capture the full impact on the patient and help to avoid potential clinical misdirection.

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