Commentary: Quality of Spirometry Testing

Thomas L. Petty, MD

Spirometry is necessary for the diagnosis and monitoring of both obstructive and restrictive lung diseases. Today, the most rapidly growing health problem in the United States is chronic obstructive pulmonary disease (COPD). COPD is now the fourth most common cause of death and the only cause of death that is rising among the top ten causes. There is also an increasing prevalence of interstitial lung diseases. Both obstructive and interstitial lung diseases are identified and monitored by spirometry.

THE ESSENCE OF SPIROMETRY

Spirometry measures air flow from fully inflated lungs. Effort is required to fully fill the lungs to the maximum. A forced expiratory breath of a full 6 seconds is then required to fully empty the lungs. This is the forced vital capacity WC). Normal lungs empty in 6 seconds or less. It is now known that forced expiratory volume in 6 seconds (FEV_6) is a good surrogate for the full FVC (1, 2). The other important test is the measure of flow, or forced expiratory volume in 1 second (FEV_1). Other so-called tests of small airways function, such as $FEF_{25\%-75\%}$, are not recommended (3). They do not measure small airways disease any more accurately than the FEV, does. The FEV_1/FVC ratio is an important derived number. Normally, the FEV_1/FVC (or FEV_1/FEV_6), is 70–75%, or more. Lower ratios indicate an obstructive ventilatory disorder. A high ratio (ie, >85%) indicates very rapid lung emptying of a small vital capacity and is indicative of a restrictive ventilator-y defect.

Spirometry measures muscular effort, elastic recoil, small airway function, large airway function, and interdependence between alveoli and small airways. The common obstructive and restrictive ventilatory defects are listed in Table 1. Figure 1 presents a simple algorithm that helps to differentiate between obstructive and restrictive ventilatory defects.

QUALITY CONTROL ISSUES

The calibration of all spirometers should be tested using a 3-L syringe. A technician or doctor with known spirometric values can also be used to check on spirometry accuracy (4).

Spirometric tests are effort dependent. Thus, the patient must cooperate to fully inflate the lungs. Initiating expiratory airflow with a blast so that peak flow is achieved within one tenth of 1 second (0.1 second) and a full forced expiration for 6 seconds without interruption is required. Software on modem flow-sensing spirometers monitors the quality of the expiratory effort, the time from initiation of air flow to peak flow, and a complete tracking of the expiratory time-volume or flow-volume curve. Poor efforts or incomplete efforts are detected, and coaching instructions are offered by visible cues from the readout of the spirometer. Repeatability within 3% is required on most devices. Comparison with predicted normal values, based on age, sex, height, and race, offers an interpretation for the clinician. The new handheld devices are accurate when compared with a standard laboratory instrument (5). One such device is illustrated in Figure 2.

Previous concerns about inadequate or improper testing, particularly with poor end expiratory efforts, can be minimized by application of modem clinical spirometers (6).

THE NATIONAL LUNG HEALTH EDUCATION PROGRAM

The National Lung Health Education Program (NLHEP) is a new national health care initiative that
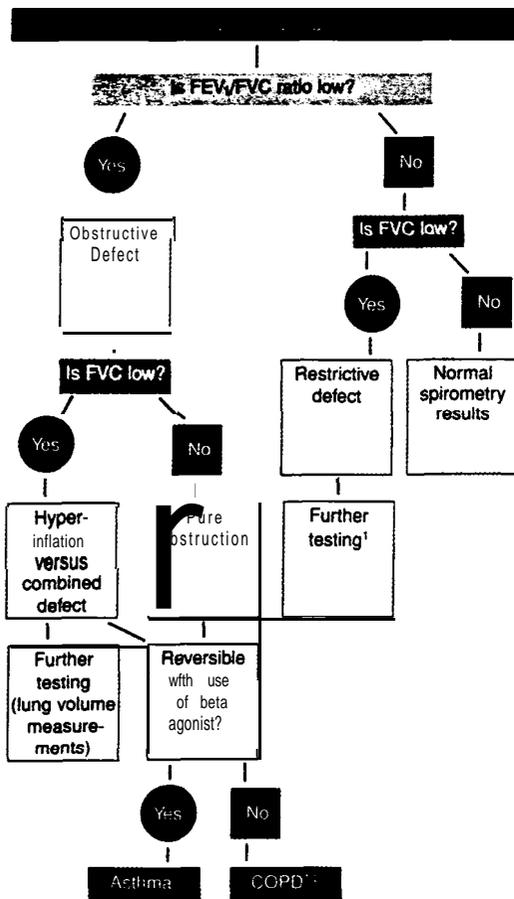
Dr Petty is with the National Lung Health Education Program. Denver, Colo.

Corresponding author: Thomas L. Petty, MD. National Lung Health Education Program. HealthOne Center, 1850 High St, Denver, CO 80218 k-mail: nlhep@aol.com).

Table 1

Common Obstructive and Restrictive Ventilatory Disorders

Obstructive	Restrictive
Asthma	Idiopathic fibrosing alveolitis
Asthmatic bronchitis	Interstitial pneumonitis and fibrosis (associated with drug reactions [eg, bleomycin {Blenoxane}], occupational exposure [eg, asbestosis], or collagen diseases [eg, rheumatoid arthritis])
Chronic obstructive bronchitis	Fibrotic residue of disseminated granulomas (eg, tuberculosis, histoplasmosis)
Chronic obstructive pulmonary disease (COPD, a generic term that includes asthmatic bronchitis, chronic bronchitis, bronchitis, and emphysema. These states commonly overlap).	Sarcoidosis
Cystic fibrosis	Thoracic deformities
Emphysema	Congestive heart failure

aims to encourage the use of spirometry in all primary care physicians' and other specialists' offices (7, 8). The foundation for the NLHEP can be found in the Lung Health Study (9), which showed that smoking cessation leads to an improvement in ventilator-y function, as judged by FEV, values compared with continued smoking (Figure 3). The NLHEP recommends using the FEV, as a surrogate for FVC (8). Normal lungs empty in 6 seconds or less. Using a shorter expiratory time creates less stress on the subject and is easier for the spirometry technician, The FEV_6 bears a close relation to the FVC and is suitable for diagnosing obstructive and restrictive ventilator-y abnormalities (1, 2).

The third National Health and Nutrition Examina-

1. If clinical correlation is present.
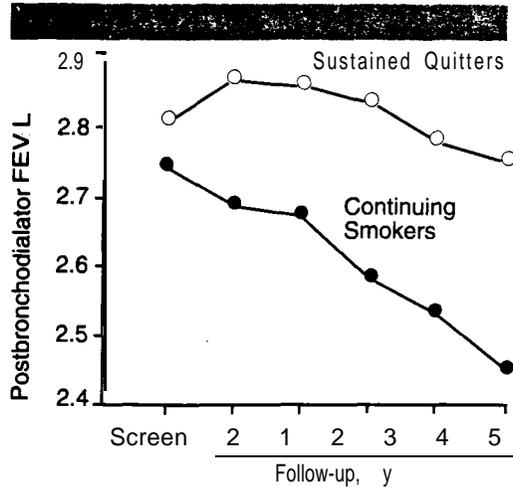2. Some COPD may have a reversible component.

figure 1. Algorithm for interpreting spirometry results. COPD indicates chronic obstructive pulmonary disease; FEV,, forced expiratory volume in 1 second; and FVC, forced vital capacity.

Figure 2. A handheld spirometer.

Figure 3. Mean postbronchodilator forced expiratory volume at 1 second (FEV,) for participants who were sustained quitters (O) and continuing smokers (●). The 2 curves diverge sharply after baseline. Adapted from *JAMA*. 1994;272:1502.

tion Survey (NHANES III) (10), was an extensive study of a large, noninstitutionalized and nonmilitary population. Most of the subjects in this study underwent spirometry. This is the largest database for both subjects with normal and subjects with abnormal lung function from the US population. NHANES III found a huge underdiagnosis of COPD, even in symptomatic patients (10). Thus, a challenge exists to find early-stage disease and to treat it with smoking cessation and bronchoactive drugs before it evolves into late-stage COPD.

The early identification of inflammatory fibrotic restrictive abnormalities will often detect patients in early stages of disease. A more specific diagnosis made through consultation with a pulmonologist may lead to anti-inflammatory therapy, which can reverse abnormal lung function in subsets of this population. These patients commonly have desquamative interstitial pneumonia (DIP), bronchiolitis obliterans with organizing pneumonia (BOOP), or nonspecific interstitial pneumonitis (NSIP) (11, 12). Most patients with idiopathic usual interstitial pneumonitis (UIP) have a poor prognosis, with essentially no response to immunosuppressive drugs (12). These patients should be enrolled

in controlled clinical trials designed to study the basic inflammatory processes involved.

SUMMARY

Spirometry, like blood pressure measurement, is a measurement of 2 values which represents a simple expression of a complex process. Abnormal spirometry predicts an increased mortality from all causes including heart attack, lung cancer, stroke, and COPD. Primary care physicians and specialists should perform spirometry testing in all smokers over age 45 and in any person with shortness of breath, chronic cough, excess mucus production, or wheeze.

References

1. Hankinson JL, Odencrantz JR, Fedan KB. Spirometric reference values from a sample of the general US population. *Am J Respir Crit Cure Med.* 1999;159:179–187.
2. Swanney MP, Jensen RL, Crichton DA, et al. FEV_6 is an acceptable surrogate for FVC in the spirometric diagnosis of airway obstruction and restriction. *Am J Respir Crit Care Med.* 2000;162:917–919.
3. Stanescu DC, Rodenstein DO, Hoeven C, et al. "Sensitive tests" are poor predictors of the decline in forced expiratory volume in one second in middle-aged smokers. *Am Rev Respir Dis.* 1987;135:585–590.
4. Enright PL, Hyatt RE. *Office Spirometry: A Practical Guide to the Selection and Use of Spirometers.* Philadelphia, Pa: Lea & Febiger; 1987:253.
5. Schoh RJ, Fero L, Shapiro H, et al. Performance of a new screening spirometer at a community health fair. *Chest.* In press.
6. Eaton T, Withy S, Garrett JE, et al. Spirometry in primary care practice: the importance of quality assurance and the impact of spirometry workshops. *Chest.* 1999;116:416–423.
7. Petty TL, Weinmann GG. Building a national strategy for the prevention and management of and research in chronic obstructive pulmonary disease. *&MA.* 1997;277:246–253.
8. Ferguson GT, Enright PL, Buist AS, et al. Office spirometry for lung health assessment in adults. A consensus statement from the National Lung Health Education Program. *Chest.* 2000;117: 1146–1161. (in preparation)
9. Anthonisen NR, Connett JE, Kiley JP, et al. Effects of smoking intervention and the use of an inhaled anticholinergic bronchodilator on the rate of decline of FEV,. The Lung Health Study. *JAMA.* 1994;272:1497–1505.
10. Mannino DM, Gagnon RC, Petty TL, et al. Obstructive lung disease and low lung function in adults in the United States: data from the National Health and Nutrition Examination Survey, 1988-1994. *Arch Intern Med.* 2000;160:1683–1689.
11. Katzenstein AA, Myers JL. Idiopathic pulmonary fibrosis. Clinical relevance of pathologic classification. *Am J Respir Crit Care Med.* 1998;157:1301–1315.
12. Selman M, King TE Jr, Pardo A. Idiopathic pulmonary fibrosis: prevailing and evolving hypotheses about its pathogenesis and implications for therapy. *Ann Intern Med.* 2001;134:136–151.