

We begin the year with the proceedings of the 48<sup>th</sup> RESPIRATORY CARE Journal Conference, Pulmonary Function Testing. We are indebted to conference co-chairs Gregg Ruppel and Paul Enright, and to each of the faculty, for the success of this conference. These papers should be of interest, not only to those who regularly perform and interpret pulmonary function tests (PFTs), but also to those who are involved in pulmonary function testing on a more occasional basis.

As discussed by McCormack, the variability in  $D_{LCO}$  testing limits the utility of the test. Variability is attributable to differences in equipment, testing conditions, patient factors, and reference equations. Variability can be minimized by ensuring that equipment meets recommended standards, implementing effective quality control programs, standardizing testing conditions and testing procedures, and accounting for pertinent patient characteristics.

Lung volumes are considered part of a complete pulmonary function test. But, as pointed out by Ruppel, there are few clear cases where lung volumes are discriminatory. Confirming a restrictive pattern when vital capacity is reduced is perhaps the most important indication. Although body plethysmography is often considered more accurate than gas dilution methods in the presence of obstruction, this has recently been challenged; computed tomography may help to delineate the true underlying physiology.

The diagnosis of asthma is often based upon nonspecific clinical symptoms of cough, wheeze, and shortness of breath. The physical examination and measurements of pulmonary function are often unremarkable in patients with asthma, thereby complicating the diagnosis of the disease. Busse reviews approaches to the diagnosis of asthma when PFTs are normal, and focuses on the use of various bronchial provocation tests to detect underlying airway hyper-responsiveness.

As described by Salzman, many phenotypic measurements of severity from pulmonary function testing correlate with mortality in COPD. A composite parameter like the BODE index, however, performs better. The presence of airflow obstruction increases the risk of lung cancer in COPD patients. Bronchodilator responsiveness aids in distinguishing asthma from COPD, as do inflammatory biomarkers. Although genetics may be helpful, alpha-1 antitrypsin deficiency is the only genetically-determined phenotype that has relevance. The best promise may be in composite scores for distinguishing asthma from COPD, and for guiding therapeutic options.

The latest standards published by the American Thoracic Society/European Respiratory Society in 2005 have attempted to incorporate some differences for the pediatric population for spirometry, but more work needs to be done. While it is recognized that spirometry is the primary pulmonary function test for children, Seed and colleagues point out that there are a number of circumstances where the addition of plethysmography and lung diffusion measurements are necessary. With better standardization of pulmonary function testing in children, the age limits for testing can be extended to below 6 years of age and sometimes even younger.

There is much clinical interest in using pulmonary function tests to determine risk from medical and surgical interventions. As discussed by Hnatiuk, the ultimate goal is early detection of pulmonary abnormalities to improve patient outcomes. However, achievement of this goal has proved to be challenging. It is clear that more research, involving more rigorously designed studies,

will be necessary before definitive answers are available.

As described by Kaminsky, airway resistance is traditionally measured by relating airflow and driving pressure using body plethysmography. Other methods to measure airway resistance include the forced oscillation technique (FOT) and the interrupter technique; these methods may be easier to perform than spirometry. Alternative methods may provide more sensitive measures of airway resistance, but the clinical importance of any of the measures of airway resistance over traditional spirometry is unclear.

The shuttle walk, stair climb, and 6-minute walk test (6MWT) require minimal equipment and technical support. At the other end of the spectrum, the cardiopulmonary exercise test (CPET) is more complex. The 6MWT has diagnostic utility in many cardiopulmonary disorders. However, as pointed out by Pichurko, CPET remains superior for the evaluation of unexplained dyspnea, formal evaluation of impairment and disability, detailed evaluation of congestive heart failure, and in selected patients prior to lung resection surgery.

As discussed by Haynes, the pulmonary function technologist must be intelligent, conscientious, and possess critical thinking skills. Monitoring of technologist performance and technologist feedback improves the quality of testing, but this is utilized by a minority of clinical laboratories. Pulmonary function laboratory accreditation is urgently needed to protect the public from potential misdiagnosis and inappropriate treatment due to spurious data.

As pointed out by Miller and Enright, the 2005 ATS/ERS guidelines for interpreting PFTs lack recommendations for the best reference equations for lung volumes and  $D_{LCO}$ , and for non-whites. The pre-test probability of lung disease should be determined using a short questionnaire. Unfortunately, less common PFT patterns and those resulting from comorbid conditions are not discussed by the guidelines.

The complex topic of how the lower limit of the normal (LLN) should be defined is addressed by Culver. For spirometry, only low values are considered to be abnormal, so the LLN is taken to be equal to the 5th percentile of a healthy, non-smoking population. Simple and commonly used rules of thumb are inaccurate and will cause misclassification. The analysis and mathematical descriptions of reference data have become increasingly sophisticated in recent years, but the interpretation of values near the LLN continues to carry uncertainty. A future goal for the pulmonary community would be the development of risk stratified outcome data that would allow an estimation of the probability of disease with progressive decrements in lung function.

Should we keep pushing for a spirometer in every doctor's office? Enright points out that quality PFTs are difficult to obtain in the offices of primary care providers. He suggests a 2-stage program. In patients who are smokers, COPD is ruled out by measuring FEV<sub>1</sub> or peak flow. Those with abnormal values should be referred for good quality spirometry. Enright identifies respiratory therapists as valuable participants in this program.

MacIntyre discusses the future of pulmonary function testing. Tests of the future might include exhaled breath analysis, sophisticated analyses of lung mechanics and gas exchange, cardiac and tissue oxygenation assessments, and imaging technologies. Adoption of any new technology will require clear evidence that the new technology is a real adjunct to clinical decision-making. These tests will require improvements in device performance, high quality technologists, properly trained interpreting clinicians, and good reference standards.