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ELDER CARE

A Resource for Interprofessional Providers

Pulmonary Function Tests in Older Adults

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Indications for Measuring Pulmonary Function

Common indications for pulmonary function testing (PFT) in older adults are symptoms that suggest lung disease, such as dyspnea, chest tightness, cough, and wheezing. However, some older patients may not experience these symptoms even in the presence of lung disease because they will instinctively limit their activities to avoid exertion that might cause the symptoms to occur. Thus, their low activity levels may preclude symptoms, even in the presence of significant (but undiagnosed) pulmonary disease. There is also evidence to suggest that older individuals have a diminished perception of bronchospasm compared with younger adults. With these concerns in mind, it is reasonable to have a lower threshold for obtaining PFTs in older adults.

Spirometry

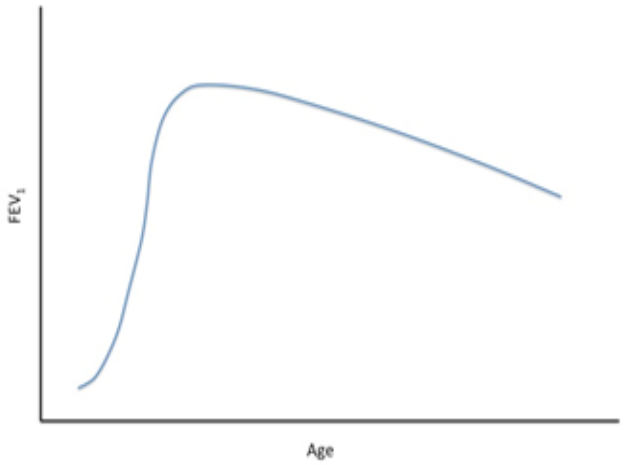
The most common PFT is spirometry, which measures the volume of air exhaled from the lungs during a forced expiratory maneuver. Most older adults are able to successfully complete this test, but potential challenges may affect performance in some individuals. For example, patients must be able to hear the technician and understand instructions, form a tight seal with their lips around the mouthpiece, inhale maximally, and then exhale with sustained maximal effort over several seconds to obtain accurate results.

Spirometric measurements include forced expiratory volume in one second (FEV_1), forced vital capacity (FVC), and the ratio of these values (FEV_1/FVC). Both FEV_1 and FVC decline with age, but the decline in FEV_1 is greater (Figure 1). Thus, the FEV_1/FVC ratio also declines with age.

The FEV_1/FVC ratio is useful in the diagnosis of obstructive lung diseases. However, because it changes over the lifespan, the definition of obstruction in older patients has been controversial.

The Global Initiative for Chronic Obstructive Lung Disease (GOLD) guidelines indicate that a fixed ratio (FEV_1/FVC <0.70) should be used to define obstruction, but there is concern this may lead to over-diagnosis among older patients, all of whom experience a decline in FEV_1/FVC. The American Thoracic Society currently recommends defining obstruction by an FEV_1/FVC below the 5th percentile for the adult population (see resource list on back page).

Figure 1. Changes in FEV_1 Over the Lifespan



After lung growth during childhood and adolescence, FEV_1 peaks in the third decade of life and then subsequently declines with age. Risk factors associated with more rapid FEV_1 decline include tobacco use, occupational exposures, and bronchial hyper-responsiveness.

Measurement of Lung Volumes

Lung volumes are commonly measured in response to abnormal spirometry to confirm the presence of a restrictive ventilatory defect or to evaluate for hyperinflation and air trapping due to an obstructive ventilatory defect. Lung volumes, including total lung

TIPS FOR USING PULMONARY FUNCTION TESTS (PFTs) IN OLDER ADULTS

- Be alert for subtle symptoms of pulmonary disorders in older adults, as many older adults will instinctively limit their physical activity to avoid dyspnea and thus not recognize that they may have a problem with their breathing.
- Using the cut-off value for FEV_1/FVC <70% to define obstruction is recommended by GOLD guidelines but may result in over-diagnosis in older adults. Using the cut-off value of FEV_1/FVC below the 5th percentile is a more conservative definition that is recommended by the American Thoracic Society.
- Use measurement of arm span (tip of one hand to tip of the other) as a substitute for height when interpreting PFTs in patients who have kyphosis or other conditions that may "artifactually" decrease their height.

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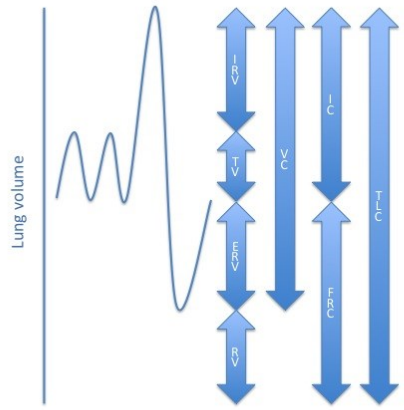
capacity (TLC) and residual volume (RV) (Figure 2), may be determined using body plethysmography or a gas dilution technique. TLC, which usually remains constant with aging, is reduced in restrictive lung diseases. RV, which increases with age, may be further increased in obstructive lung disorders.

Assessing Gas Exchange

Assessment of gas exchange involves measuring the diffusing capacity of the lungs for carbon monoxide (DLCO)

Figure 2. Lung Volumes and Capacities



The graph demonstrates changes in lung volume with tidal breathing, followed by a maximal inspiratory maneuver and then a maximal expiratory maneuver. IRV =inspiratory reserve volume, ERV = expiratory reserve volume, RV = residual volume, VC = vital capacity, IC = inspiratory capacity, FRC = functional residual capacity, TLC = total lung capacity

and/ or arterial blood gas analysis. DLCO decreases with age, as does resting arterial oxygen tension (PaO_2). Reference equations specific for age have been established, but in general, PaO_2 <70 mmHg is abnormal. Both DLCO and PaO_2 may be further reduced in disorders that compromise gas exchange, including interstitial lung disease, pulmonary edema, pulmonary vascular disease, and emphysema.

Assessing Respiratory Muscle Strength

Respiratory muscle strength decreases with age. Maximal inspiratory and expiratory pressures (MIP, MEP) can be measured in a PFT lab, but the results are dependent on patient effort. Thus, further testing may be needed when results indicate respiratory muscle weakness. Normal values, however, rule out significant weakness.

PFT Interpretation in Older Adults

Typical patterns on PFTs in common conditions affecting lung function in older adults are shown in the table below. Lung function varies by age, sex, and height, and complex equations incorporate these variables to predict normal PFT values. Measured values are compared with predicted values to determine if they are abnormal. Of note, many of these equations were developed from datasets with age limits (e.g., analysis of NHANES III excluded data from patients of age >80 years when establishing normal PFT values), so caution is advised when interpreting PFTs in older patients.

Decline in height with advancing age can affect PFT predicted values. For patients with kyphosis in particular, arm span (from the tip of one outstretched arm to the other) may be substituted for height to determine predicted values. Normal PFT values are lower in shorter individuals, so using arm span avoids the over-estimation of pulmonary function that can occur if height measurements are "artifactually" short due to kyphosis or other conditions.

Table. Typical PFT Patterns Associated with Common Disorders Affecting Lung Function

DIAGNOSIS	*FEV_1/FVC*	*FEV_1*	*FVC*	*DLCO*
COPD	↓	↓	N / ↓	↓
Asthma	N / ↓	N / ↓	N / ↓	N
Interstitial disease	↑ / N	N / ↓	↓	↓
Heart failure	N	N / ↓	N / ↓	↓/↑
Kyphosis	↑ / N	↓	↓	N

FEV_1=forced expiratory volume in one second, FVC=forced vital capacity, DLCO=diffusing capacity of the lungs for carbon monoxide, COPD=chronic obstructive pulmonary disease, N=normal.

References and Resources

Berry CE, Wise RA. Interpretation of pulmonary function test: issues and controversies. Clin Rev Allergy Immunol 2009; 37: 173-180.

Cerveri I, Zoia MC, Fanfulla F, et al. Reference values of arterial oxygen tension in the middle-aged and elderly. Am J Respir Crit Care Med 1995; 152: 934-941.

Enright PL. Aging of the respiratory system. Hazzard's Geriatric Medicine and Gerontology, 6th edition. McGraw-Hill, 2009.

Global Initiative for Chronic Obstructive Lung Disease. Pocket Guide to COPD Diagnosis, Management, and Prevention. 2013. https://goldcopd.org/wp-content/uploads/2016/12/wms-GOLD-2017-Pocket-Guide.pdf

Pellegrino R, Viegi G, Brusasco V, et al. Interpretative strategies for lung function tests. Eur Respir J 2005; 26: 948-968.

Sharma G, Goodwin J. Effect of aging on respiratory system physiology and immunology. Clin Interv Aging 2006; 1: 253-260.

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