

Office Based Spirometry

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Spirometry in the primary care office is a valuable tool that can be used to assist with the diagnosis of respiratory symptoms and the management of obstructive and restrictive lung disease. With the most common obstructive diseases, spirometry use has been shown to lead to more appropriate medical therapy and better patient outcomes than clinical diagnosis alone, even without specialty input. This article comprises a review of the indications, barriers to use, and procedural components of office based spirometry for the family physician. Interpretation of spirometric results and their use in clarifying a diagnosis and guiding treatment decisions are reviewed.

INTRODUCTION

Office based spirometry is a common pulmonary function test ordered or performed in a family physician's office. Asthma is the top chronic condition present in children and is the 8th leading cause of death in children 5-14 years of age with 75% of medical care for this condition provided by primary care physicians.^{1,2} COPD is the 3rd leading cause of death annually and is estimated to affect 24 million Americans.^{3,4} These health problems are commonly encountered in a family physician's office both initially and for chronic management, yet they remain largely underdiagnosed and undertreated.⁵ Monitoring symptoms and office based spirometric measurements of asthma and COPD have not routinely been available, assessed, or emphasized to family physicians like many other chronic conditions. However, proper spirometric performance and interpretation provides objective evidence to support a clinical diagnosis and measurable data to monitor treatment.^{6,7} With the ease of use of modern spirometers and relatively low equipment cost, it can be effectively incorporated as an office tool by family physicians with the goal of better medical management and motivating patients toward important lifestyle modifications, resulting in improved patient outcomes. Our purpose is to review the indications, barriers, and evidence for spirometry use. We will outline its step by step performance to assure quality and reproducible results, and discuss interpretation with the specific indicators for specialty care referral.

INDICATIONS

The most common patient symptoms that lead to spirometry testing are chronic dyspnea on exertion and cough. Other

symptoms that may indicate a need for spirometry include chronic sputum production, chest tightness, and shortness of breath not related to exertion.^{6,7} Once a diagnosis has been made, spirometry may also be used to monitor patients with COPD and asthma for progression of disease and the effects of therapy.⁶ For the physician with advanced skill and training, spirometry can provide quantifiable diagnostic clues for restrictive diseases, upper airway obstruction, and mixed pulmonary defects that are helpful to manage cardiopulmonary diseases. Additionally, its quantification can help to prognosticate cardiopulmonary diseases and evaluate perioperative risk.^{6,7}

BARRIERS TO USE

The demands of a busy practice, lack of training to perform spirometry or interpret results, infrequency of use, and lack of reimbursement have all been cited as barriers to providing this service in the primary care setting.^{5,6} However, studies have confirmed that spirometry is relatively quick to perform in the office [average time for patient instruction was 5.6 +/- 3.1 minutes and performance of spirometry (without bronchodilator) was 6.4 +/- 3.5 min].⁵ Improvement of spirometry quality and interpretation by primary care physicians was found in multiple studies with the following interventions: 1) Office Spirometry Certification (OSC) or similar training, 2) utilization of an "over-reading" service for quality control of the test and interpretation similar to that of radiologic services, 3) use of a designated ancillary staff person to offer opportunistic spirometry, or 4) centralized PFT laboratory referral. These interventions have been recommended and in studies resulted in improved diagnostic accuracy, guideline adherence, and/or patient care outcomes compared to conventional evaluation alone.^{5,6,8,9}

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EVIDENCE IN USE

Recent studies have shown that spirometry use in asthma and COPD is associated with improved outcomes due to more accurate classification of disease state and severity, leading to more appropriate medical management. Walker et al showed that primary care spirometry testing improves the accuracy of COPD diagnosis and management without input from specialists. This also led to a reduction in COPD exacerbations treated by the PCP in the year following spirometry.⁸

Asthma clinical diagnosis and management often misclassifies disease severity and results in undertreatment. This was illustrated in the Nair et al report showing that abnormal spirometry results were just as likely to be present in pediatric asthma patients with a normal history and exam as in patients with an abnormal history and exam. Spirometry use changed management in 15% of patient visits, and in the absence of PFT results, providers tended to overestimate how well a patient's asthma was controlled, even with specialist care.² A recent Danish outcomes study showed decreased hospitalization rates in pediatric patients whose primary care physicians performed spirometry initially, or within 6 months of a clinical diagnosis of asthma.¹⁰

When *not* to use spirometry:

Spirometry should not be ordered in a low disease probability population (i.e. all smokers) due to potential false positive results in the population above age 65 and false negative results in the younger age group. Definitive evidence is mixed for spirometry as a motivational tool for smoking cessation in that patients may be ready to quit without additional testing and its subsequent cost. Normal results may lull patients into a false sense of security that their tobacco use has not negatively impacted their health. Furthermore, expert consensus is that consistent physician inquiry regarding readiness for change, counseling and tobacco cessation medication management should be offered to all patients who smoke at each visit no matter their lung function.⁴ Therefore, spirometry by PCPs should be reserved for high-risk patients (i.e. smokers >40 years of age with symptoms, who would benefit from in-depth management), as spirometry is likely to identify a predominance of patients with mild to moderate airflow obstruction who would not experience added health benefits of treatment.^{4,11}

Spirometry use in children under age 8 is not recommended for family physicians, as machine normative values may not include data for those younger than 8 years of age and acceptability/reproducibility may be less than ideal unless performed by experienced labs.¹²

PROCEDURAL PERFORMANCE¹³

Materials:

1. Mouth piece
2. Spirometer
3. Computer software to record data (if not within spirometer)
4. Nose clip (optional)
5. Chair
6. MDI with albuterol and spacer (if initial test is suggestive of pulmonary disease)

Procedure:

Preparation

1. Record the patient's information including name, weight, and height, past medical history and surgical history to ensure the predicted values are appropriate.
2. Record the patient's smoking status and history.
3. Confirm that the patient has not used any inhaled drugs in the 4 hours prior to the test.
4. Calibration of the spirometer should be performed once daily with a 3L syringe.

Procedure and Coaching the Patient

1. The procedure should be explained and demonstrated to the patient to get the most accurate and reproducible results.
2. Explain that the patient should take the deepest breath possible then blow out as fast and as hard as possible for as long as possible. This should be at least 6 seconds for adults and adolescents and 3 seconds for children 10 years old or younger.
3. Demonstrate the procedure for taking a deep inspiration and forced expiration.
4. Demonstrate how to pinch the nose if no nose piece is available.
5. Explain how to form a seal around the mouth piece with the lips.

Procedure

1. Make sure the patient is sitting upright without leaning forward or backwards. The patient should not be standing.
2. The patient must put their mouth on the mouth piece and form a complete seal with their lips.
3. Make sure the tongue or teeth are not blocking the mouthpiece.
4. Have the patient inhale as deeply as possible.
5. They should pinch their nose or use a nose clip before exhalation to keep air from escaping out the nose and giving a falsely low result.
6. Coaching to continue exhaling is important to ensure the maximal expiratory volume is achieved.

Acceptability and Reproducibility

1. An acceptable maneuver requires a sharp peak in the flow curve and an expiratory duration greater than 6 seconds for adults or 3 seconds for children age 10 or younger.
2. The patient must do three rounds of forced expiration to get the FVC and FEV1.
3. The three blows must produce FVCs within 200ml. The maximal FVC and FEV1 are used, even when produced on differing blows, if the results are within the range of reproducibility.

Post-Bronchodilator Testing

1. 400 µg of Albuterol may be administered through MDI (with spacer if needed) after the first round of tests if results show abnormal lung functions.
2. Spirometry is repeated after 15 minutes to test for reversibility of lung function abnormalities.

INTERPRETATION^{6,12}

When interpreting a spirometric result in the primary care office, the three main values that should be assessed are the FVC, FEV1, and FEV1/FVC.

The **FVC**, or forced vital capacity, measures the maximum volume of air and a maximum effort that a person can exhale. The predicted FVC is calculated (often by the computer software recording results) using patient specific values for height, weight, age, and ethnicity, and the actual value should be compared to this number. This value is normal or elevated in an obstructive lung disease but may be decreased in a restrictive lung disease or with submaximal respiratory effort.

The **FEV1**, or forced expiratory value in one second, is the total volume of air that can be forcefully exhaled in one second after full inspiration. This value is important in determining the degree of obstructive lung disease. The value will be normal or minimally decreased in a patient with restrictive lung disease and <80% (or 0.8) in a patient with obstructive lung disease.

The **FEV1/FVC ratio**, or the fraction of a maximal exhalation that can be forcefully exhaled after one second, is important in differentiating between obstructive and restrictive lung disease. A value less than 70% (or 0.7) of the predicted value is indicative of obstructive lung disease, such as asthma or COPD.⁶

The visual representation of a patient's respiratory effort over time via flow volume curves can assist the physician in quickly comparing different efforts for reproducibility and classification. Typical patient patterns for normal, obstructive, and restrictive lung disease are shown in the Figures below. The normal pattern has a quick upstroke with gradual consistent decline while meeting predictive lung volumes throughout (Figure 1). The obstructive pattern has a quick peak followed by a prolonged concave expiratory phase with a flat gradual decline at the end (Figure 2). The restrictive pattern has a fast upstroke and gradual consistent decline but the volumes are diminished and the breath ends sooner compared to the norm (Figure 3).

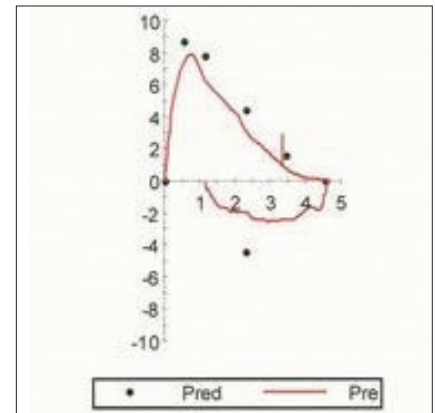


FIGURE 1: Normal spirometry curve. The dots represent predicted flow volumes based on the patient's age, race and size. The red line shows the patient's respiratory effort prior to bronchodilator administration.

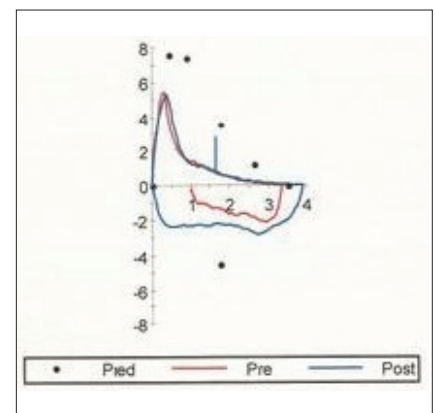


FIGURE 2: Moderate obstructive pattern with significant reduction of FEV1/FVC. The dots represent predicted flow volumes. The red line shows the prebronchodilator curve and the blue line shows the postbronchodilator curve.

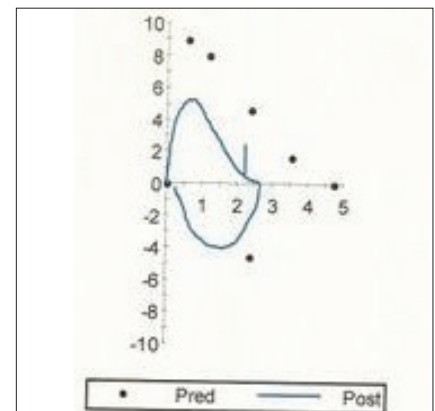


FIGURE 3: Moderate restrictive pattern with significant volume reduction but normal shaped flow curve. The dots represent the predicted volume and flow. The blue line represents the postbronchodilator effort.

Routinely, a post bronchodilator trial is not necessary unless airway obstruction is present, but it is particularly important in newly diagnosed patients. Reversibility of airway obstruction, a hallmark of asthma, is typically defined as > 12% improvement of FEV1 compared to the predicted value with improvement of >0.2 L by volume.⁶

A physician's final report of spirometry data should include comments about the patient effort, whether the data is acceptable and reproducible, as well as the dose of bronchodilator medication (if used). The result should be stated as normal, borderline or abnormal and further defined as an obstructive or restrictive pattern if abnormal. An obstructive pattern should have comments regarding reversibility suggestive of asthma or partial to no reversibility more suggestive of COPD or asthma that is poorly controlled. Furthermore, an obstructive pattern consistent with COPD can be staged according to severity from the GOLD Criteria (Table 1).^{14,15}

TABLE 1: GOLD Criteria for COPD Severity Staging

Category/Severity Stage	FEV ₁ /FVC	FEV ₁ (% Predicted)
Normal (healthy patients)	0.80	~100
I: Mild	<0.70	≥ 80
II: Moderate	<0.70	50 to <80
III: Severe	<0.70	30 to <50
IV: Very Severe	<0.70	<30 ^a

USE IN CLINICAL PRACTICE

Making a diagnosis of respiratory disease requires a review of a combination of the patient's history, exam, and confirmation of the presence of respiratory disease using spirometry.⁶ Although the most common obstructive diagnoses to consider are asthma and COPD, other diseases may be suggested based on spirometry done in the primary care setting. These include alpha 1 antitrypsin deficiency, bronchiectasis (cystic fibrosis), or inhalational exposures. In cases where there is clinical evidence for restrictive lung disease (FVC < 85% and FEV1/FVC >0.70) or mixed disease with overlapping restrictive and obstructive pattern (FVC <85% and FEV1/FVC<0.55), referral to a specialist or pulmonary function laboratory with facilities to measure Total Lung Capacity (TLC) and gas transfer is recommended.⁶ Specialty referral is also recommended in cases where there is clinical or spirometric evidence of central or upper airway obstruction.⁶ It is unusual for a patient with COPD to have symptomatic dyspnea due to airflow obstruction when the FEV1 is greater than 50% predicted. Therefore, if the symptoms are moderate to severe

and the spirometry results show only mild obstruction, another source of dyspnea may need to be considered.¹⁶ The differential diagnosis in this clinical scenario may include other pulmonary causes such as pulmonary hypertension or embolus or cardiac conditions such as CHF or coronary artery disease.

Although reversibility testing is used to distinguish between COPD and asthma, bronchodilator responsiveness is less in smokers than non-smokers. Therefore, bronchodilator effects on symptoms, treatment management, and improvements in exercise capacity may not be reliably predicted based on this numeric response alone.¹⁴ Monitoring of actual lung volume is more valuable than comparisons with predicted values. In healthy adults, the expected decline is 20-35 ml per year. In patients with lung disease, variability in repeated measurements is larger than in healthy subjects. Therefore, a posttreatment improvement of more than 225 ml in FEV1 and 325 ml in FVC, is likely to be a meaningful sign of treatment success.⁶

SUMMARY

Spirometry is an underutilized source of relevant and helpful information to the primary care physician. The equipment is low cost and readily available, and the time commitment for initial physician and staff training are minimal. Interpretation of three simple respiratory measurements can help clarify whether the patient's symptoms are related to obstructive or restrictive lung diseases or a non-pulmonary cause.

Studies clearly show that patients with spirometry confirmed obstruction receive medical management more consistent with published guidelines than those diagnosed based on clinical presentation alone.

The benefits of providing comprehensive care to children and adults in the primary care setting encourages patient compliance with testing, minimizes cost, and improves patient outcomes.

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REFERENCE WEBSITES:

OSC Training:¹⁴

www.aarc.org/osc

Spirometry Performance Video:

http://www.youtube.com/watch?v=s8pxdtp_Duw