Spirometry Aids the Differential Diagnosis of Asthma and COPD

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A web-based learning module

Target audience:
Primary care physicians

Disclosures

Paul L. Enright, MD, has disclosed the following relevant financial relationships:
Financial Relationship with a Commercial Interest:
Consultant or Advisory Board:
Pfizer Chantix
Gilead IPF
Expert Testimony:
Setter Legal Asbestosis
Relationship with Tobacco Entity: none

Barbara P. Yawn, MSc, MD, has disclosed the following relevant financial relationships:
Financial Relationship with a Commercial Interest:
Novartis, BI-Pfizer: COPD screening study
Merck: advisory board adult vaccines
BiPfizer grant: Screening for COPD in family medicine practice
Novartis grant: Rate of exacerbations before and after COPD diagnosis
Merck: Incidence of Herpes Zoster eye complications
Financial Support from a Non-Commercial Source:
AHRQ grants: asthma tools for primary care and RCT, screening for post partem depression, use of LAMA in black adults with asthma
CDC grant: Herpes Zoster surveillance
Relationship with Tobacco Entity: none
Learning Objectives

• Appropriately screen patients for risk of asthma and COPD.
• Accurately interpret spirometry results.
• Identify characteristics that differentiate COPD and asthma.
• Classify spirometric abnormalities from mild to very severe.
• Monitor disease progression with spirometry.
• Cite evidence regarding new treatments in COPD that have been effective in slowing progression of the disease.
• Recognize patient symptoms/test results that should lead to referral to a pulmonary specialist.
• Evaluate and address comorbidities of COPD.

All 10 of these adults are your patients.

All report 20 to 40 pack-yrs of smoking and a chronic cough.

Some of them also report dyspnea.

1 has COPD.
1 has asthma.
“In patients with respiratory symptoms, particularly dyspnea, spirometry should be performed to diagnose airflow obstruction.”

The Clinical Efficacy Assessment Subcommittee of the American College of Physicians


The Alphabet Soup

The traditional Volume-Time graph

FEV1 = 2.9 liters
FVC = 3.9 liters
FEV1/FVC = .76

The exhalation starts here
The Flow-volume Curve

- This curve was invented to make the recognition of spirometry patterns easier.
- You can’t measure the FEV1 here.
- The blue Xs mark predicted values.

Exhalation starts here

Naomi
48 y/o bank teller


What is her FEV1?
- a) 1.0
- b) 2.2
- c) 3.0
- d) 6.5
Naomi

Her FEV1 and FVC were grossly underestimated due to a very short expiratory maneuver. You coach her for a 6 second test and the results become entirely normal.

- Dx: Cough due to rhino-sinusitis with post-nasal drainage
- Rx: generic loratidine qAM and nasal lavage BID prn congestion
- Two weeks later she calls with the news that she no longer has a cough and her boyfriend enjoys kissing her. She will quit smoking with him.

Empiric Treatment for Rhinosinusitis

- First gen. antihistamine
  - Chlorpheniramine
  - Brompheniramine
  - Diphenhydramine
  - Second-generation may be less sedating, but are less effective for cough due to PND

- Decongestant
  - Long-acting pseudoephedrine
  - Phenylephrine is less effective
  - Consider a salt water sinus rinse
**Respiratory Symptoms in Smokers are Often Not Due to COPD**

- *Chronic cough* in smokers is just as likely due to post-nasal drip, GERD, or asthma.
- *Dyspnea* in smokers is often due to poor conditioning, CVD (CHF, PVD), the metabolic syndrome, or anemia.
- *Hyperinflation* is also caused by asthma.

**Don’t prescribe a COPD inhaler until the “O” in COPD is confirmed.**

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**Frank**  
75 y/o retired plumber  
Productive morning cough for many years. Drinks a 6-pack and smokes 30 cigs since teens. Tried to quit last New Year. Dyspnea during sex or golfing. BMI 34. Normal lung sounds. Normal CXR.

- **FEV1/FVC = 0.60**  
- **FEV1 3.0 (94% pred)**
A $100 Pocket Spirometer Rules Out Clinically Important COPD* in 80% of Smokers

- It takes just 1 minute.
- If FEV1 >90% predicted, prompt smoking cessation.
- If FEV1 <90% predicted, refer for pre-post-BD diagnostic spirometry.

* Low FEV1/FVC and FEV1 <65% pred. post-BD

“Treatment for stable COPD should be reserved for patients who have respiratory symptoms and FEV1 less than 60% predicted, as documented by spirometry.”

The Clinical Efficacy Assessment Subcommittee of the American College of Physicians

Charlie
68 y/o musician

Non-productive cough for several years. Perfume and smoking cigs worsens it, but inhaling THC helps. Denies dyspnea during concerts, sex, and lawn bowling. Mannitol challenge in Sydney was normal. BMI 22.

Normal ENT & lung exam.

FEV1 = 5.0 liters (125%)
FEV1/FVC 5/6 = 0.83

The allergist next door measures Charlie's eNO = 80 ppb (high)
Dx: Eosinophilic bronchitis
Rx: Inhaled corticosteroid BID
2 wks later: no cough

Ralph
52 y/o attorney from Chicago

Chronic, non-productive morning cough for many years. Smoked since age 18. Multiple attempts at quitting, most recently using nicotine gum.
No allergies. No dyspnea.
Athletic since high school.
Doris
78 y/o nurse

Chronic cough as long as she can remember. Colds “go to her chest” for several weeks, especially in the winter. Smoked since age 40 (started during her first divorce). Hay fever since age 6, but no history of asthma. Sinus headaches several times a year. Scattered wheezing on forced expiration. Hyperinflation on CXR.

FEV1 1.5 L pre-BD (42% pred)
FEV1 2.4 L post-BD (67% pred)

What is the most likely cause of her chronic cough?

a) Asthma
b) COPD
c) Rhinosinusitis
d) GERD
• Asthma was confirmed by the airway obstruction & large response to albuterol.
• Hyperinflation on chest X-ray (or HRCT) occurs both with asthma and COPD.
• The PFT lab also performed a DLCO test, which was normal, ruling out emphysema.
• You prescribed a combo inhaler.
• 4 weeks later, she was overjoyed. Her FEV1 increased to 3.2 liters (89% pred).

Doris

Wife complains of his chronic cough. Smoked since age 18 when he joined the Marines. Hay fever since age 6. Sinusitis several times a year. No dyspnea (but no exercise). Wheezing on forced expiration. Hyperinflation on CXR.

FEV1 1.5 L pre-BD (44% pred)
FEV1 1.7 L post-BD (48% pred)
FVC 3.0 L pre-BD (63% pred)
FVC 3.8 L post-BD (79% pred)
What is the most likely cause of his chronic cough?

a) Asthma  
b) COPD  
c) Rhinosinusitis  
d) GERD

• COPD is highly likely considering the severe airway obstruction which persists post-BD.  
• You ordered a lung HRCT (apical panlobular emphysema).  
• The PFT lab also performed a DLCO test (40% pred), and 6-min walk (350 yards with oxygen desaturation to 86%).  
• You order a coronary artery calcium scan which suggests substantial CAD.  
• Due to his comorbidity, you obtain a pulmonary consult.
Lena
75 y/o retired flight attendant

She was diagnosed with COPD 3 years ago, but complains of multiple side-effects from her high-dose combination inhaler. She has a 30 pk-yr smoking history. She quit “cold turkey” 3 years ago.

FEV1 = 2.8 L (105% pred)
FEV1/FVC = 0.68

She does not have COPD. Her chronic cough was a side-effect of an ACE inhibitor.

John
55 y/o artist

Intermittent but chronic cough. Intermittent smoking since age 25. Three bouts of “walking pneumonia.” Dyspnea for 3 years whilst snowboarding. BMI 27. Clear lungs. SpO2 = 93%

Hyperinflation on CXR.

Refer to a PFT lab for good quality spirometry and a methacholine challenge test for possible asthma.
Sometimes the Post-test Probability of a Disease is the Same as Pre-test

High confidence

Low confidence

FEV1/FVC: 50%
Abnormal “Black”

70%
LLN “Grey”

90%
Normal “White”

Accept uncertainty when results are borderline abnormal or of poor quality.

Cathy
55 y/o casino manager

Increasing dyspnea on exertion for 3 years. Always coughs when lying down. Sour taste after spicy Mexican food. HCTZ for hypertension. Uncle with emphysema. BMI 36. Clear lungs. Osteopenia on CXR.

Spirometer interpretation: “Mild restriction”

Dx: GERD due to obesity
Rx: Low carb diet, exercise, antacids

Spirometer interp: "Mild restriction"
Dx: GERD due to obesity
Rx: Low carb diet, exercise
   Bupropion & nicotine gum

**Summary (Key Points)**

1. Spirometry is very helpful for patients with a chronic cough or new-onset dyspnea on exertion.
2. Asthma symptoms with normal spirometry do not rule out mild, intermittent asthma.
3. A normal FEV1 rules out clinically-important COPD.
4. Moderate to severe obstruction in an adult smoker: very high probability of COPD.
2007 Asthma Guidelines


NHLBI Asthma Guidelines


1991  Asthma is an inflammatory disease
1997  Early recognition and treatment based on severity assessment
2002  Update on selected topics
2007  Control and more spirometry use
### Classifying Asthma Severity: Impairment

<table>
<thead>
<tr>
<th>Impairment</th>
<th>Classification of Asthma Severity</th>
<th>Intermittent</th>
<th>Persistent</th>
<th>Severe</th>
</tr>
</thead>
<tbody>
<tr>
<td>Symptom</td>
<td></td>
<td>&lt;2 d/wk</td>
<td>&gt;2 d/wk; not daily</td>
<td>Daily</td>
</tr>
<tr>
<td>Nighttime</td>
<td></td>
<td>≥2x/ mo</td>
<td>1-2x/ mo</td>
<td>&gt;1x/ wk</td>
</tr>
<tr>
<td>awakening</td>
<td></td>
<td>≤2x/ mo</td>
<td>3-4x/ mo</td>
<td>&gt;1x/ wk</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Often 7x/ wk</td>
</tr>
<tr>
<td>Risk</td>
<td>Exacerbations requiring oral</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>system</td>
<td>systemic corticosteroid</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>0-1/year</td>
<td>≥2 attacks in 6 mo requiring oral steroid or ≥4 wheezy episodes/1 yr lasting &gt;1 day AND risk factors for persistent asthma</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

#### Normal FEV1/FVC:
- 8–19 y: 85%
- 20–39 y: 75%
- 40–59 y: 70%
- 60–80 y: 60–70%

*EIB = exercise-induced bronchoconstriction.


### Classifying Asthma Severity: Risk

<table>
<thead>
<tr>
<th>Risk</th>
<th>Classification of Asthma Severity</th>
<th>Intermittent</th>
<th>Persistent</th>
<th>Severe</th>
</tr>
</thead>
<tbody>
<tr>
<td>Exacerbations requiring oral systemic corticosteroid</td>
<td>0–1/year</td>
<td>≥2 attacks in 6 mo requiring oral steroid or ≥4 wheezy episodes/1 yr lasting &gt;1 day AND risk factors for persistent asthma</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

#### Relative annual risk of exacerbations may be related to FEV1.

Consider severity and interval since last exacerbation. Frequency and severity may fluctuate over time for patients in any severity category.

#### Recommendations for all age groups
- Children ≤ 4 y
- Children 5–11 y
- Persons ≥ 12 y

Comorbid Conditions

- Evaluate for comorbid conditions during history and when asthma cannot be well controlled.

<table>
<thead>
<tr>
<th>Chronic comorbid conditions</th>
<th>Treating comorbid conditions may adequately improve overall control of asthma and lessen requirements for asthma medications.</th>
</tr>
</thead>
<tbody>
<tr>
<td>- Allergic bronchopulmonary aspergillosis (ABPA)</td>
<td>- Obesity</td>
</tr>
<tr>
<td>- Gastroesophageal reflux disease (GERD)</td>
<td>- Rhinitis/sinusitis</td>
</tr>
<tr>
<td>- Obstructive sleep apnea (OSA)</td>
<td>- Stress/depression</td>
</tr>
</tbody>
</table>

Characteristics That Help Distinguish COPD From Asthma

<table>
<thead>
<tr>
<th>Feature</th>
<th>COPD</th>
<th>Asthma</th>
</tr>
</thead>
<tbody>
<tr>
<td>Onset</td>
<td>Often in midlife</td>
<td>Often in childhood</td>
</tr>
<tr>
<td>Family history</td>
<td>Variable</td>
<td>Often</td>
</tr>
<tr>
<td>Medical or social history</td>
<td>Smoking (often ≥20 pack-years)</td>
<td>Atopy (ie, allergy and/or eczema)</td>
</tr>
<tr>
<td>Patients report symptoms as...</td>
<td>Most notable during exercise</td>
<td>Most notable at night or early morning</td>
</tr>
<tr>
<td></td>
<td>“Mostly bad days”</td>
<td>“Mostly good days”</td>
</tr>
<tr>
<td>Airflow obstruction</td>
<td>May be some reversibility with bronchodilation</td>
<td>Largely reversible with bronchodilation</td>
</tr>
</tbody>
</table>


Beeh et al Questionnaire to Differentiate Asthma and COPD

- A short questionnaire asking about age at onset, smoking history, atopy status, and cough quality was developed for clinical use
- High scores on the questionnaire were associated with a diagnosis of COPD

**Spirometric Diagnosis of COPD**

- COPD is confirmed by post-bronchodilator FEV1/FVC <0.7
- Consider LLN
- Post-bronchodilator FEV1/FVC measured 10-15 minutes after 2 to 3 puffs of a short-acting bronchodilator

**Spirometry-based Diagnosis Dictates How to Implement Evidence-based Therapy**

<table>
<thead>
<tr>
<th>GOLD Stage</th>
<th>I Mild</th>
<th>II Moderate</th>
<th>III Severe</th>
<th>IV Very Severe</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Active reduction of risk factors: influenza vaccine.</td>
<td>Add short-acting bronchodilators when needed</td>
<td>Add regular Rx with ≥1 long-acting bronchodilator. Add rehabilitation</td>
<td>Add inhaled corticosteroids (ICS) if repeated exacerbations</td>
</tr>
<tr>
<td></td>
<td>Long-acting bronchodilators and corticosteroids are also used for asthma but in the reverse order.</td>
<td>Consider O2 and surgery</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

2005 Severity Classification - Spirometry

Table 4. Severity of any spirometric abnormality based on the FEV₁ as % of predicted.

<table>
<thead>
<tr>
<th>DEGREE OF SEVERITY</th>
<th>FEV₁, % predicted</th>
</tr>
</thead>
<tbody>
<tr>
<td>MILD</td>
<td>&gt;70%</td>
</tr>
<tr>
<td>MODERATE</td>
<td>60-69</td>
</tr>
<tr>
<td>MODERATELY SEVERE</td>
<td>50-59</td>
</tr>
<tr>
<td>SEVERE</td>
<td>35-49</td>
</tr>
<tr>
<td>VERY SEVERE</td>
<td>&lt;35</td>
</tr>
</tbody>
</table>

"The number of categories and the exact cut-points are arbitrary."

Enright: Caution re-shifting of disease severity, false positives, excess therapy, potential conflict of interest in clinical practice guidelines


Spirometry is Useful for Monitoring Disease Progression

Changes Can Be Seen Earlier in Spirometry Than in Many Other Respiratory Parameters

<table>
<thead>
<tr>
<th>Spirometry</th>
<th>Normal</th>
<th>Borderline</th>
<th>Mild</th>
<th>Moderate</th>
<th>Severe</th>
</tr>
</thead>
<tbody>
<tr>
<td>Symptoms</td>
<td>Cough, sputum</td>
<td>Exertional dyspnea</td>
<td>Resting dyspnea</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Arterial blood gas</td>
<td>Normal</td>
<td>Hypoxemia</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Chest X-ray</td>
<td>Normal</td>
<td>Hyper-inflation</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Time
Airflow Obstruction in COPD is Partially Reversible

Postbronchodilator FEV\textsubscript{1} measured after administration of 80 µg ipratropium and 400 µg albuterol. Adapted with permission from Tashkin DP et al. Eur Resp J. 2008;31:742-750.

BODE Index*

<table>
<thead>
<tr>
<th>Variable</th>
<th>Points on the BODE Index</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>0</td>
</tr>
<tr>
<td>FEV\textsubscript{1} (%) predicted</td>
<td>≥65</td>
</tr>
<tr>
<td>Distance walked in 6 min (m)</td>
<td>≥350</td>
</tr>
<tr>
<td>MMRC dyspnea scale‡</td>
<td>0-1</td>
</tr>
<tr>
<td>Body-mass index</td>
<td>&gt;21</td>
</tr>
</tbody>
</table>

*Total possible values range from 0-10. BODE = body mass index, airflow obstruction, dyspnea, and exercise capacity.

Increased Mortality: BODE Score and ATS Staging

A. 

B. 

Spirometry Ameliorates Gender Bias

Hypothetical male patient with COPD symptoms

Hypothetical female patient with COPD symptoms

COPD suspected on the basis of symptoms

42%

74% COPD accurately diagnosed on the basis of spirometry

31%

Peak Flow Meters are Cheaper but Less Efficient and Less Accurate

- If PEF >70% predicted, prompt smoking cessation.
- If PEF <70% predicted, refer for pre- & post-BD diagnostic spirometry.
- Use for asthma exacerbation assessment.

Jithoo A, Nelson S, ERS 2010 abstracts

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John is 69 y/o Never Smoker
Ht: 166.4 Wt: 73.6

FVC 2.32 63%
FEV₁ 0.69 24%
FEV₁/FVC 29.9

Reversibility of FEV₁ to 70%

Severe obstruction with normal peak flow. Has marked reversibility. May be severe asthma but will have to follow.
Mary is 37 y/o With 10 Pack Year Smoking History, Family History of Early COPD in Several People
Ht: 177.2  Wt: 62.3  BMI: 19.9

FVC  4.65  90%  4.93  +6%
FEV₁  1.93  46%  2.07  +7%
FEV₁/FVC  41.6

Moderate obstruction with hyperinflation and air trapping
Little bronchodilator response
Alpha 1-antitrypsin screening

Randall is 63 y/o Smoker With History of Asthma as a Young Adult and Repeated Chest Colds. Mild Dyspnea, Persistent Cough & Wheeze; Compensated Congestive Heart Failure
Ht: 182.2  Wt: 83.3

FVC  3.74  74%  4.79  +28%
FEV₁  1.93  50%  2.81  +46%
FEV₁/FVC  51.6  58.7

Moderate obstruction with large bronchodilator response, hyperinflation and air trapping on CXR
?Asthma and Chronic Bronchitis
Nancy is 66 y/o With Severe Dyspnea
80 Pack Years, Quit 10 Years
Ht: 173.5   Wt: 68.9

FVC  3.76  88%  4.70  +25%
FEV₁ 0.80  24%  0.98  +23%
FEV₁/FVC 21.2

Less than 200 cc increase in FEV or FVC

Very severe airways obstruction with marked hyperinflation, small bronchodilator response, oxygen desaturation
COPD requiring desaturation evaluation

Pedro is 42 y/o With Mild Dyspnea on Exertion,
30 Pack Years, Ex-smoker
Ht: 177.8   Wt: 215.5   BMI: 68.2

FVC  2.25  44%  2.33  +4%
FEV₁ 1.77  43%  1.92  +8%
FEV₁/FVC 78.7

Restriction in obesity
Affect may be minimal
Increased diffusing capacity is common
Obstruction unrelated to obesity
Severe COPD
Trend showing dip with rejection episode

61 Y/O Transplant Patient
Ht: 162.6   Wt: 87.5

Using Spirometry to Monitor Lung Function

Address Co-morbidities of COPD

Lung Cancer
Anxiety, Depression
Pulmonary Hypertension
Cardiovascular Disease
Anemia
Peripheral Muscle Wasting & Dysfunction
Diabetes
Osteoporosis
Metabolic Syndrome
Peptic Ulcers
Cachexia
GI complications

Asthma or COPD Management

- Suspect
  - Spirometry

- Severity
  - Symptoms
  - FEV1

- Select RX

- Modifications

- Inadequate
- Adequate

- Why inadequate?
- Inadequate
- Adherence
- Triggers
- Co-morbidities
- Psycho-social
- Inhaler technique

In Addition to Improved Care, be Paid for Your Work—Claim Reimbursement

<table>
<thead>
<tr>
<th>Procedure</th>
<th>CPT Code</th>
<th>MC $ (approx.)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Spirometry</td>
<td>94010</td>
<td>$36</td>
</tr>
<tr>
<td>Bronchospastic Spirometry</td>
<td>94060</td>
<td>$64</td>
</tr>
<tr>
<td>Albuterol MDI</td>
<td>J7613</td>
<td>Carrier Priced</td>
</tr>
<tr>
<td>Flow Volume Loop</td>
<td>94375</td>
<td>$40</td>
</tr>
<tr>
<td>MDI Teaching</td>
<td>94664</td>
<td>$17</td>
</tr>
<tr>
<td>Simple Pulmonary Exercise Test</td>
<td>94620</td>
<td>$80</td>
</tr>
</tbody>
</table>
Smoking Cessation Counseling

- 99406 – 3-10 minutes — $13 (approximate)
- 99407 – >10 minutes — $25 (approximate)

- May bill with an E&M code using a 25 modifier and different diagnoses like cough, asthma or COPD

- Limit 8 visits in 12 month period

Summary

- Asthma and COPD can be difficult to separate
- Spirometry is the most important tool to help confirm
- But you have to suspect respiratory problems
- As in any chronic disease—one test is not diagnostic
- You can do and interpret spirometry successfully