QUICK GLANCE GUIDE TO SPIROMETRY

Spirometry: a measure of airflow (how fast) and volume (how much)

American Lung Association® IN MINNESOTA

Minnesota COPD COALITION

Definitions:

Forced Vital Capacity (FVC): the volume delivered during an expiration made as forcefully and completely as possible starting from full inspiration

Forced Expiratory Volume in the first second (FEV$_1$): the volume delivered in the first second of an FVC maneuver

Obstruction: flow limitation is observed during spirometry. If the observed FEV$_1$/FVC ratio is down 10 or more from the predicted, obstruction is present.

Restriction: Spirometry with low FVC (< 80%) can only suggest restriction. Further testing is needed to confirm.

Examples of obstructed and restricted flow loops

Peak flow

FVC

Interstitial pulmonary fibrosis flow loop (restrictive lung disease)

Normal flow loop

Mildly obstructed flow loop

Moderately obstructed flow loop

Severely obstructed flow loop
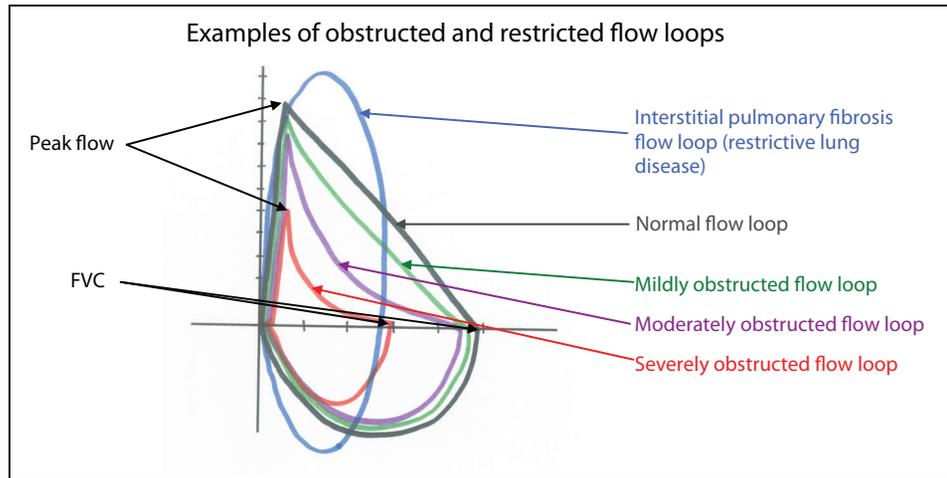
Spirometry must establish a solid baseline meeting all criteria for acceptability and repeatability. For patients 8-80 years old, use NHAN ES III. For children under the age of 5-8 years, use Wang. Testing children < age 5 is likely to be unsuccessful. Always have your patient sit when performing spirometry. Follow all OSHA and JCAHO standards for infection control.

Contraindications:

- Recent surgery
- Within one month of a myocardial infarction
- Recent pneumothorax
- Unable to understand directions or inability to seal mouthpiece

CPT codes for spirometry:

94010 spirometry 94060 spirometry with bronchodilator (pre- and post-test)
When using these CPT codes, better reimbursement happens when current symptoms are associated with the appropriate ICD9 code for asthma or COPD.

Refer to a specialist:

- If patient has *severe obstruction*
- If patient has a *restrictive pattern*
- If patient *does not respond to medications*

Acceptability criteria from the American Thoracic Society

- Good start of test/rapid rise
- Single, clearly defined peak
- Good end of test (6 sec for adults/3 sec for children)
- Free from artifacts (i.e. cough, glottic closure, leaking)

Examples of unacceptable tests
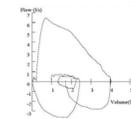
Slow start of test	Rounded peak	Early termination	Cough in first second
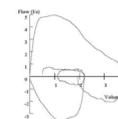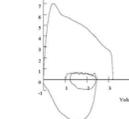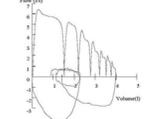
Repeatability criteria for the American Thoracic Society:
Three (3) acceptable tests must be performed with two (2) tests having FEV$_1$ and FVC within .15L or 150mL of each other.

	Actual	Predicted	% Predicted
FVC (L)	3.62	3.41	106
FEV1 (L)	4.00	4.03	99

	Actual	Predicted	% Predicted
FVC (L)	3.64	3.41	107
FEV1 (L)	3.99	4.03	99

	Actual	Predicted	% Predicted
FVC (L)	3.70	3.41	109
FEV1 (L)	4.07	4.03	101
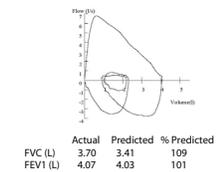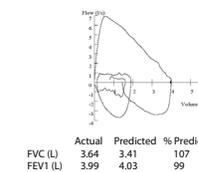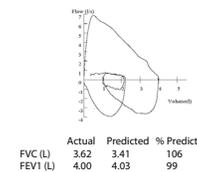
Coaching patients through spirometry:

Instruct patient to breathe normally. When patient is ready, have him/her take his/her deepest breath and blow as hard as he/she can as long as he/she can. There is a learning curve for spirometry. Use positive reinforcement to build on the patient's successes. (For example, "That was really good; this time take an even deeper breath.") Always demonstrate the spirometry maneuver, especially if language is a barrier or communication issues arise.

Appropriate bronchodilator use:

If testing for reversibility, give patient 4 puffs of bronchodilator with a spacer or a standard nebulized dose. Wait 15 minutes after last dose to perform post-bronchodilator maneuver. If a patient cannot perform acceptable baseline maneuvers according to American Thoracic Society criteria or there is no evidence of airflow obstruction, do NOT give a bronchodilator.

References:
Miller M, Hankinson J, Brusasco V, *et al.* Standardisation of spirometry. *European Respiratory Journal.* 2005;26:319–338.
Pellegrino R, Viegi G, Brusasco V, *et al.* Interpretative strategies for lung function tests. *European Respiratory Journal.* 2005;26:948–968.
Global Strategy for the Diagnosis, Management, and Prevention of Chronic Obstructive Pulmonary Disease. Updated 2007. Available at http://www.goldcopd.com.
National Heart, Lung and Blood Institute National Asthma Education and Prevention Program. *Expert Panel Report 3: Guidelines for the Diagnosis and Management of Asthma.* 2007. Available at http://www.nhlbi.nih.gov.

SPIROMETRY INTERPRETATION

ASTHMA
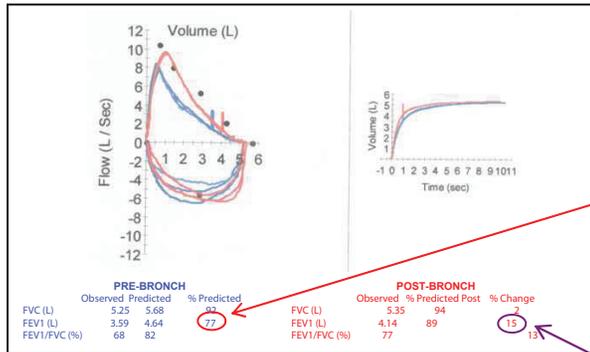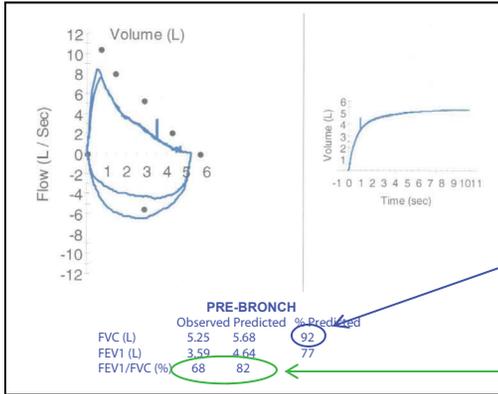
COPD
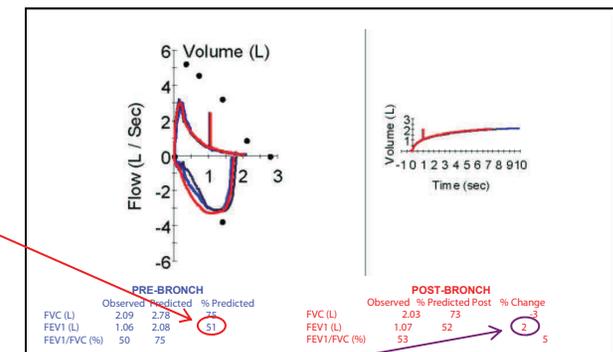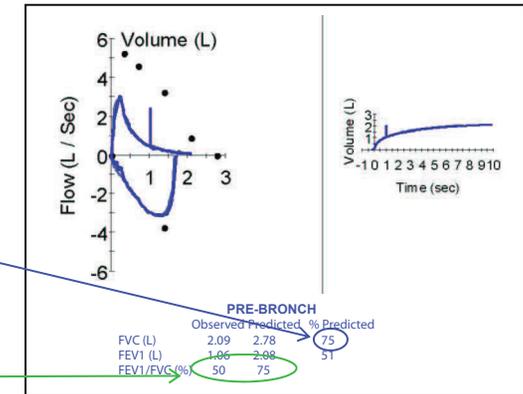
Is this a good test?
(Acceptability and repeatability criteria on reverse)

Check FVC. If normal (≥80%), restriction can be ruled out. If reduced, further testing is needed to differentiate restriction from obstruction with air-trapping.

PRE-BRONCH (Asthma)

	Observed	Predicted	% Predicted
FVC (L)	5.25	5.68	92
FEV1 (L)	3.59	4.64	77
FEV1/FVC (%)	68	82	

PRE-BRONCH (COPD)

	Observed	Predicted	% Predicted
FVC (L)	2.09	2.78	75
FEV1 (L)	1.06	2.08	51
FEV1/FVC (%)	50	75	

What is the observed ratio (FEV$_1$/FVC) compared to predicted?
Down 10 or greater = airflow obstruction

PRE-BRONCH / POST-BRONCH (Asthma)

	Observed	Predicted	% Predicted		Observed	% Predicted Post	% Change
FVC (L)	5.25	5.68	92	FVC (L)	5.35	94	2
FEV1 (L)	3.59	4.64	77	FEV1 (L)	4.14	89	15
FEV1/FVC (%)	68	82		FEV1/FVC (%)	77		13

PRE-BRONCH / POST-BRONCH (COPD)

	Observed	Predicted	% Predicted		Observed	% Predicted Post	% Change
FVC (L)	2.09	2.78	73	FVC (L)	2.03	73	3
FEV1 (L)	1.06	2.08	51	FEV1 (L)	1.07	52	2
FEV1/FVC (%)	50	75		FEV1/FVC (%)	53		5

ATS/ERS* Degree of severity of obstruction based on FEV$_1$

Degree of severity	FEV$_1$ % predicted
Mild	>70
Moderate	60-69
Moderately severe	50-59
Severe	35-49
Very severe	<35

* American Thoracic Society/European Respiratory Society

Is it reversible? ↑ FEV$_1$
≥ 12% and ≥ 200 mL in youths and adults 12+
≥ 15% and ≥ 200 mL in children < 12

Consistent with asthma diagnosis ← Yes

No →
• Airflow obstruction that is not significantly reversible does NOT rule out asthma.
• To help differentiate COPD from asthma with airway remodeling/fixed obstruction, further testing options include: $D_{L,CO}$, chest x-ray, and chest CT.

Asthma Severity

			Persistent		
		Intermittent	Mild	Moderate	Severe
5-11 years		Normal FEV$_1$ between exacerbations FEV$_1$ > 80% predicted FEV$_1$/FVC > 85%	FEV$_1$ > 80% predicted FEV$_1$/FVC > 80%	FEV$_1$ = 60-80% predicted FEV$_1$/FVC = 75-80%	FEV$_1$ < 60% predicted FEV$_1$/FVC < 75%
12 + years	Normal FEV$_1$/FVC: 8-19 yr 85% 20-39 yr 80% 40-59 yr 75% 60-80 yr 70%	Normal FEV$_1$ between exacerbations FEV$_1$ > 80% predicted FEV$_1$/FVC normal	FEV$_1$ ≥ 80% predicted FEV$_1$/FVC normal	FEV$_1$ 60-80% predicted FEV$_1$/FVC reduced 5%	FEV$_1$ < 60% predicted FEV$_1$/FVC reduced > 5%

COPD Severity

Stage I: mild	Stage II: moderate	Stage III: severe	Stage IV: very severe
FEV$_1$/FVC < 70% FEV$_1$ ≥ 80% predicted	FEV$_1$/FVC < 70% FEV$_1$ 50-80% predicted	FEV$_1$/FVC < 70% FEV$_1$ 30-50% predicted	FEV$_1$/FVC < 70% FEV$_1$ < 30% predicted or FEV$_1$ < 50% predicted plus chronic respiratory failure

Sample written asthma interpretation:
The FEV/FVC ratio being down more than 10 from predicted is consistent with airflow obstruction. The FEV$_1$ being 77% of predicted suggests a mild airflow obstruction (based on the 2005 ATS/ERS guide for severity of obstruction). The post bronchodilator study reveals a significant response to albuterol with the FEV$_1$ increasing 15% or 550cc. This finding is consistent with diagnosis of asthma although clinical correlation is needed to confirm. (Based on the 2007 NAEPP guidelines for asthma severity), this 28 year old male with a baseline FEV$_1$ of 77% has moderate persistent asthma.

Sample written COPD interpretation:
The FEV$_1$/FVC ratio being down more than 10 from predicted is consistent with airflow obstruction. The FEV$_1$ being 51% of predicted suggests a moderately-severe airflow obstruction (based on the 2005 ATS/ERS guidelines for severity of obstruction). No significant response to albuterol was revealed as the FEV$_1$ only increased 2%. Further testing revealed a diffusion capacity of 50% of predicted. The lateral chest film showed signs of hyperinflation and flattened diaphragm and the chest CT had classic changes seen in emphysema. (Based on the 2007 GOLD guidelines for COPD severity), this 74 year old female with a baseline FEV$_1$ of 51% has Stage II moderate COPD.