

Bedside Spirometry: It's More than Just a Deep Breath and Blow!

JOSÉ RAMOS, MED, RRT, RPFT

Objectives

- ▶ 1. Define the importance of the parameters being collected during bedside testing sessions.
- ▶ 2. To explain the vital information collected and why a quality testing sessions should be obtained.

The Why

October 2015, Vol 148, No. 4_MeetingAbstracts

Obstructive Lung Diseases | October 2015

Spirometry Utilization in COPD; One Health System's Experience

Bohdan Pichurko, MD; Kevin McCarthy, RPFT
Cleveland Clinic, Mentor, OH

Chest. 2015;148(4_MeetingAbstracts):692A. doi:10.1378/chest.2281089

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LETTER ► [Int J Chron Obstruct Pulmon Dis.](#) 2025 Feb 12;20:319–323. doi: [10.2147/COPD.S490781](#) 

Diagnostic Inaccuracies in COPD: Misdiagnosis, Race and Gender Disparities

[Sarah E Maus](#)¹, [Dustin L Norton](#)^{1,✉}, [Amit K Saha](#)², [Brian J Wells](#)³, [Jill A Ohar](#)¹

Episodic Diagnosis vs Diagnostic Diagnosis

Episodic:

containing or consisting of a series of loosely connected parts or events

OR

occurring occasionally and at irregular intervals

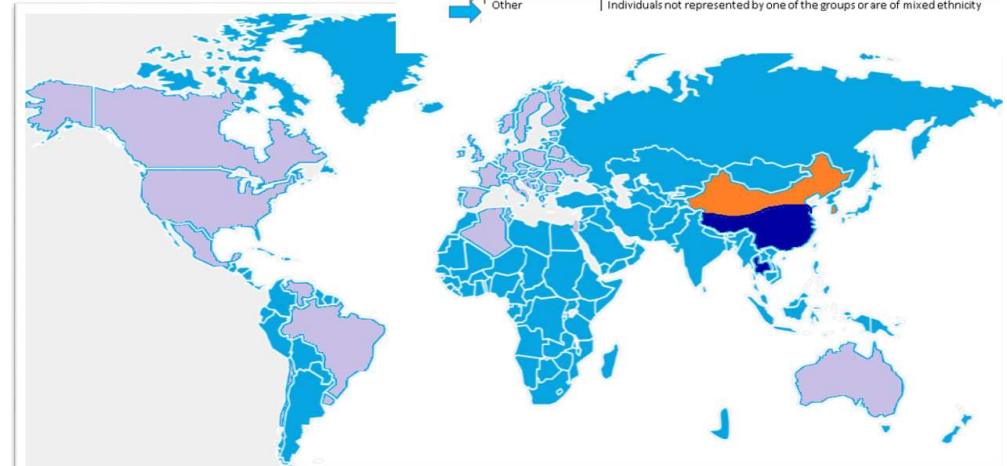
Knowing How

- ▶ What demographics do we need to know to get predicted values?
 - ▶ Common Replies
 - ▶ Height
 - ▶ Weight
 - ▶ Age
 - ▶ Hopeful Replies
 - ▶ Height
 - ▶ Age
 - ▶ Gender
 - ▶ Ethnicity*

What Should YOU Look for in a Predicted Set and Equipment?

- ▶ LLN and ULN
 - ▶ Z-scores
 - ▶ GLI 2012 (Global Lung Initiative)
 - ▶ GLI 2023 Race-neutral
- *Consistency (should be the same as your PFT lab)
- ▶ Equipment
 - ▶ Should meet 2019 ATS/ERS guidelines
 - ▶ Ability to measure flow down to 0.025L/s
 - ▶ Ability to visually evaluate in real time

Worldwide Map



How do YOU Know You're Getting the Quality

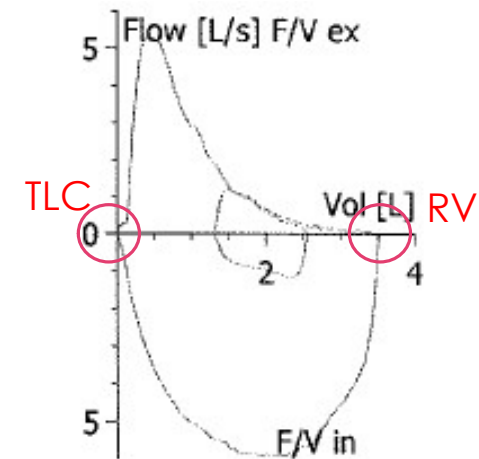
- ▶ Familiar with the most up-to-date ATS/ERS standards
 - ▶ Know what the Alphabet soup means
 - ▶ Repeatability
 - ▶ Acceptability
 - ▶ Reproducibility

How do YOU Know You're Getting the Quality

- ▶ Familiar with the most up-to-date ATS/ERS standards
 - ▶ Know what the Alphabet soup means (Measured Parameters)
 - ▶ FVC
 - ▶ FEV1
 - ▶ FEV1/FVC (Ratio)
 - ▶ FIVC

How do YOU Know You're Getting the Quality

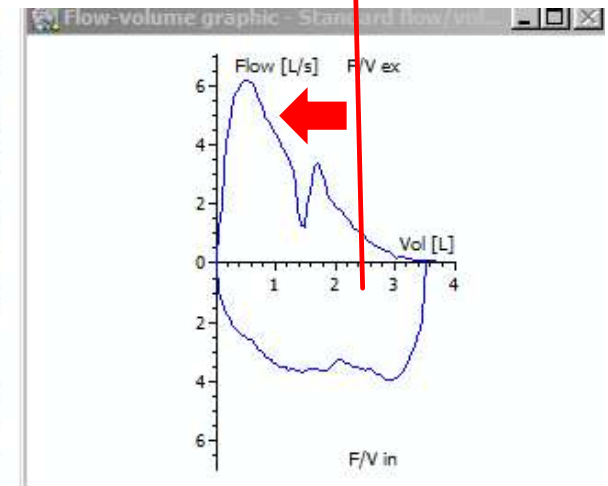
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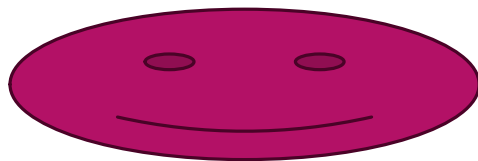
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FVC	4.45	3.55	5.36	3.65	82
FEV 1	3.32	2.55	4.09	2.51	76
FEV1%F	74.64	64.96	84.32	68.80	92
FEV 2	3.60	2.56	4.64	2.95	82
FEV 3	4.12	3.10	5.13	3.14	76
FEV3%F	91.66	87.02	96.30	86.03	94
MEF 50	4.08	2.46	5.71	2.37	58
FIF 50				3.66	
F25/75	2.64	1.08	4.20	1.44	54
FE%FIF				64.75	
FEV6				3.43	
PEF	8.23	5.87	10.59	6.11	74
FET				12.06	
FETPEF				0.08	
VBe%F				2.82	

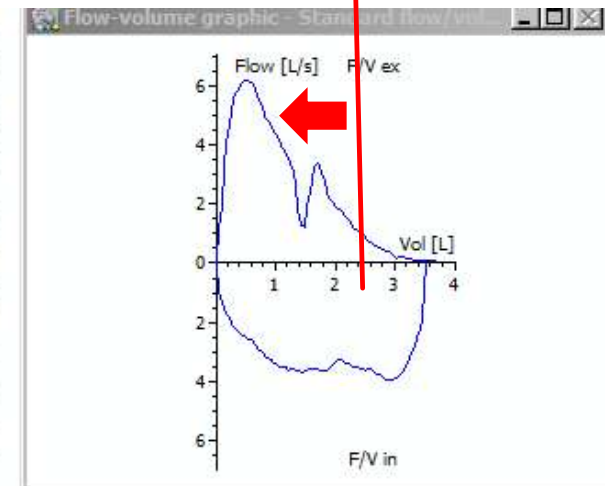


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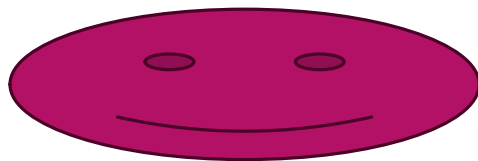
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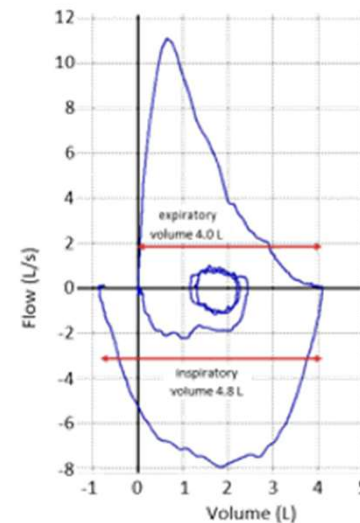
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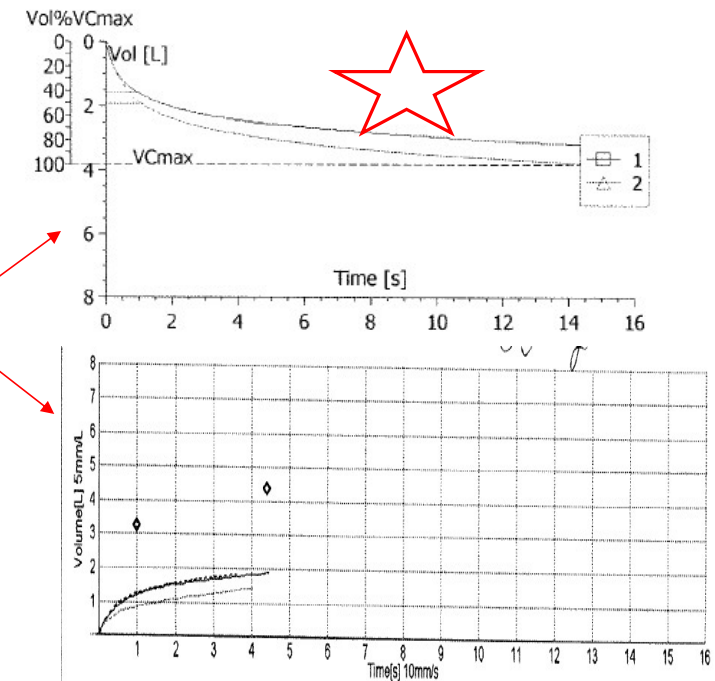
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 - ▶ FVC
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 - ▶ FEV1/FVC (Ratio)
 - ▶ **FIVC**



How do YOU Know You're Getting the Quality

- ▶ Familiar with the most up-to-date ATS/ERS standards
 - ▶ Know what the Alphabet soup means
 - ▶ FET
 - ▶ EOFE
 - ▶ VBEex or Vbe%FVC
 - ▶ FETPEF or tPEF
 - ▶ Cough

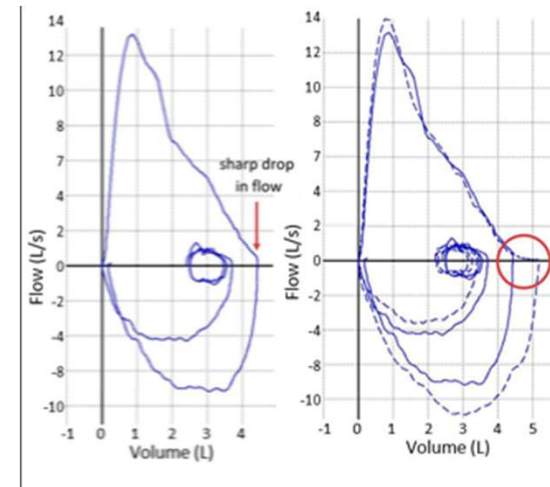
Same Patient



Which one will show the true Picture?

How do YOU Know You're Getting the Quality

- ▶ Familiar with the most up-to-date ATS/ERS standards
 - ▶ Know what the Alphabet soup means
 - ▶ FET
 - ▶ **EOFE**
 - ▶ VBEex or Vbe%FVC
 - ▶ FETPEF or tPEF
 - ▶ Cough



How do YOU Know You're Getting the Quality

► Familiar with the most up-to-date ATS/ERS standards

► Know what the Alphabet soup means

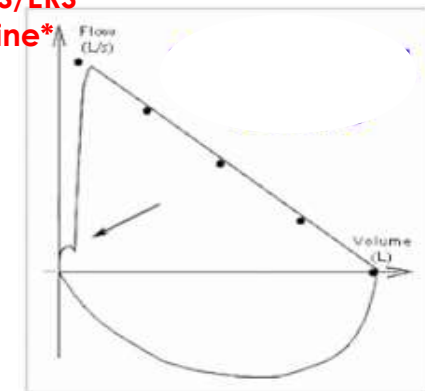
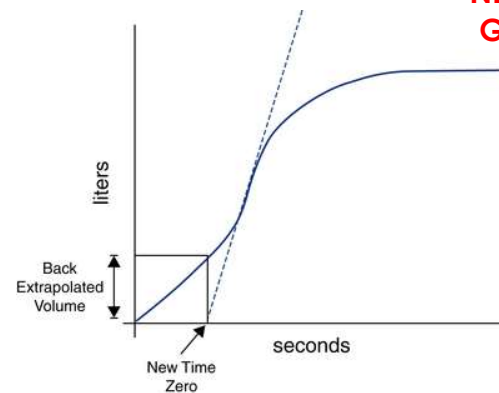
- FET
- EOFE
- **VBEex or Vbe%FVC**
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Verifies that EV is acceptable

$FVC > 2L : EV \leq 5\%$

$FVC < 2L : EV \leq 0.10L$

***NEW ATS/ERS
Guideline***



How do YOU Know You're Getting the Quality

- ▶ Familiar with the most up-to-date ATS/ERS standards

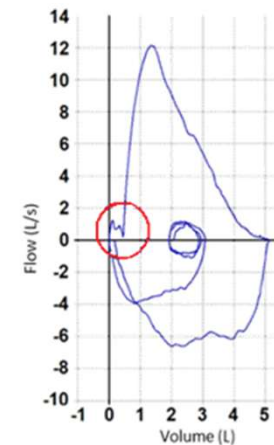
- ▶ Know what the Alphabet soup means

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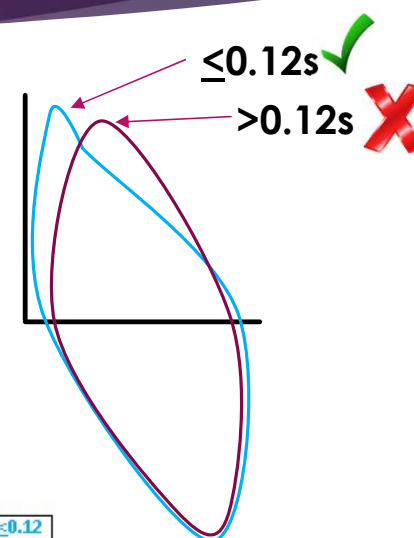
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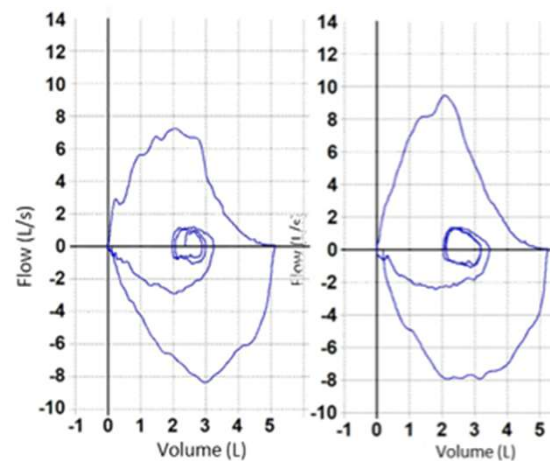
- ▶ Familiar with the most up-to-date ATS/ERS standards
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 - ▶ FET
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	Pred.	LIN	ULN	Actual FETPEF >0.12	%pred	Actual FETPEF ≤0.12
FVC	4.00	3.20	4.80	4.00	1.00	4.00
FEV1	3.00	2.40	3.60	2.71	0.90	2.52
FEV1/FVC%	0.75	0.65	0.85	0.68		0.63

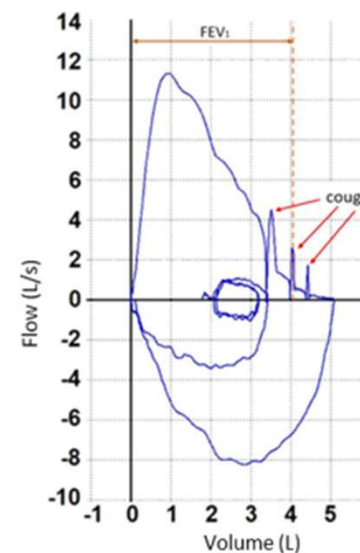
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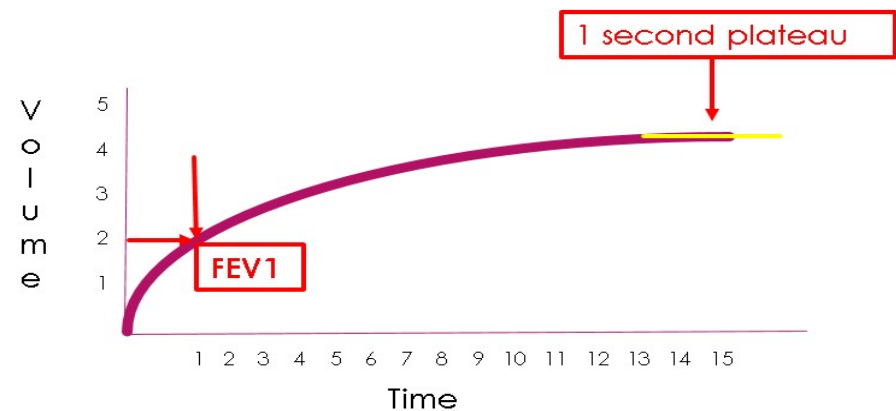
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ATS (A Tricky Summary)/ERS

- ▶ How long should you have a patient blow out for?
 - ▶ 6 seconds?
 - ▶ No longer a guideline
 - ▶ ATS/ERS 2019 Guidelines
 - ▶ A 1 second plateau in the volume time tracing 15 second
- Or
- ▶ 15 second "Forced" Expiratory Time (FET)



ATS (A Tricky Summary)/ERS

- ▶ Should the patient blow out as hard as possible the whole time?
 - ▶ Maybe?
 - ▶ ATS/ERS say's...

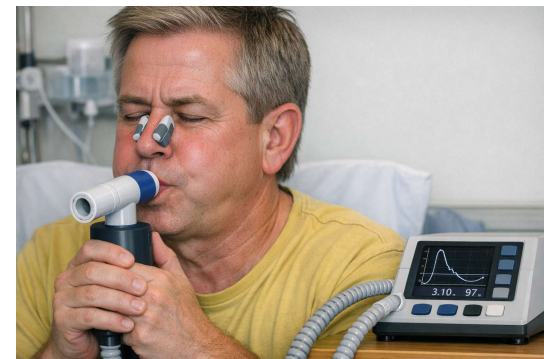
“Reducing the effort partway through the maneuver (after 4 s) may give a higher expiratory volume in some patients and may prevent glottic closure and avoid syncope, but then it is no longer a true maximally forced expiration.”



ATS (A Tricky Summary)/ERS

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 - ▶ ATS/ERS say's...

“Reducing the effort partway through the maneuver (after 4 s) may give a higher expiratory volume in some patients and may prevent glottic closure and avoid syncope, but then it is no longer a true maximally forced expiration.”



ATS (A Tricky Summary)/ERS cont.. Repeatability vs Reproducibility

- ▶ Repeatability
 - ▶ FVC & FEV1
 - ▶ 3 trials need to be within 0.15L of the largest effort for Patients >6 years old
 - ▶ 3 trials need to be within 0.10L of the largest effort for patients ≤ 6 years old
 - ▶ For patients with FVC and/or FEV1 ≤ 1.00 L should match within 0.10L
 - ▶ By default, the FEV1/FVC ratio will match
- ▶ Acceptability
 - ▶ The trial must meet the start and end of test criteria.
- ▶ Reproducibility
 - ▶ Different: day, machine, staff, etc.

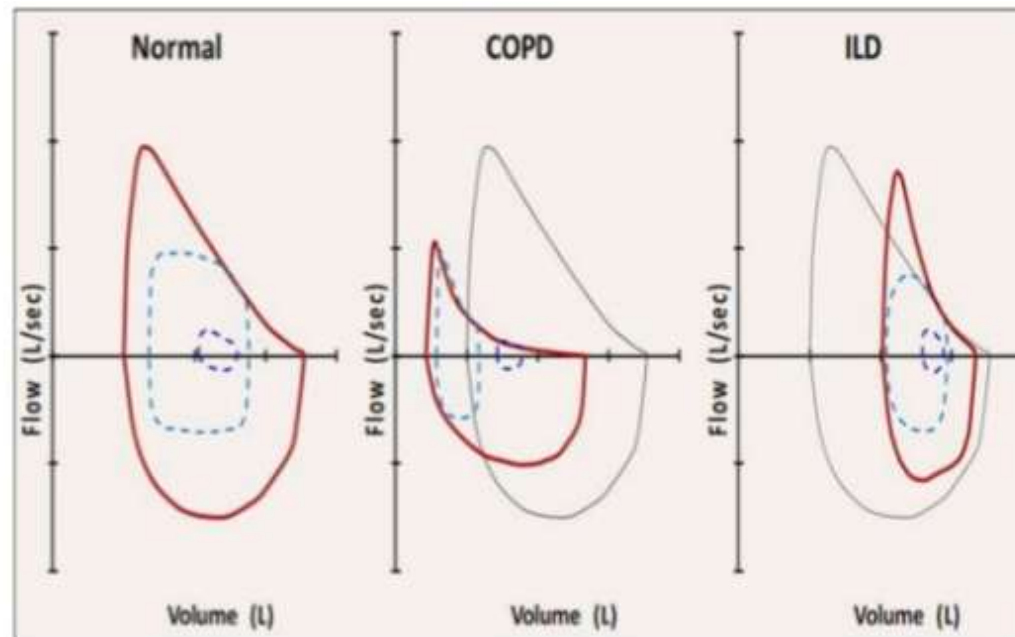
What are the potential risk?

- ▶ Missed Obstruction
 - ▶ Early Termination
 - ▶ Early Termination of Complete Inspiration
 - ▶ Poor Start of Test (VBEex or FETPEF)
- ▶ Missed Obstruction can lead to...
 - ▶ Untreated Bronchospasm
 - ▶ Extended intubation
 - ▶ Increased Re-admissions

What are the potential risk (cont.)?

- ▶ False Positive for Suggestive Restriction
 - ▶ Early Termination
 - ▶ Early Termination of Complete Inspiration
 - ▶ Poor recognition of potential glottis closure
- ▶ False Positive for Suggestive Restriction can lead to...
 - ▶ Inappropriate Testing
 - ▶ Poor Recovery
 - ▶ Postponed Surgery

Flow Volume Loops



Can a Flow Volume Loop Help Improve a Patients Quality of Life?

- ▶ Short Answer...YES!!!!
- ▶ How?

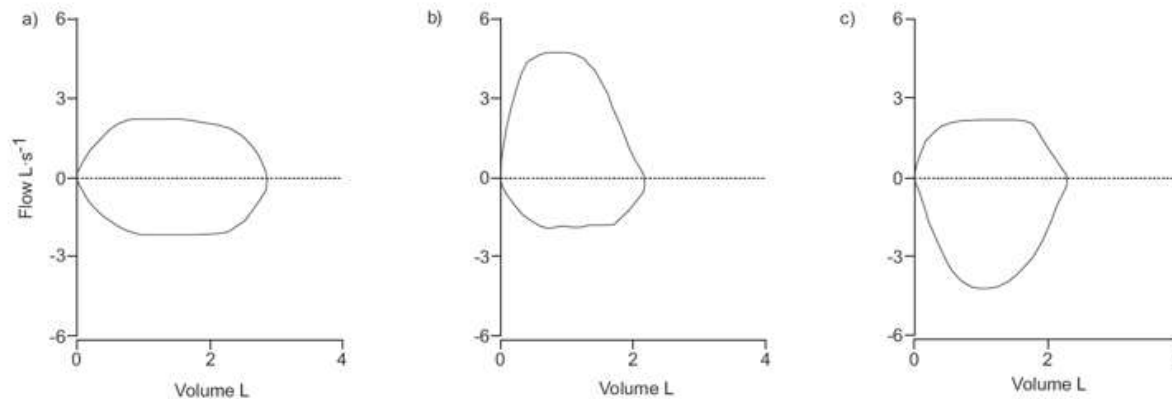
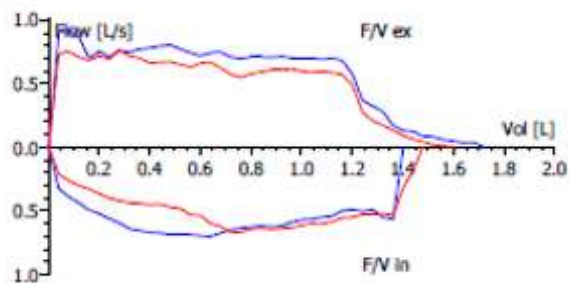


FIGURE 3. Idealised examples of a) fixed, b) variable extrathoracic, and c) variable intrathoracic airway obstruction.

Can a Flow Volume Loop Help Improve a Patients Quality of Life (cont.)?

- ▶ Short Answer...YES!!!!
- ▶ How?



7 Subglottic tracheal wall



8 Subglottic tracheal wall-after cuts



1 Subglottic tracheal wall-after dilations + steroid injections

Training Competency and Check-Offs

- ▶ Respiratory Students
 - ▶ 1st semester of respiratory school
 - ▶ 1st exposed to an Actual PFT Lab
 - ▶ 1 to 1.5 years later
 - ▶ Extent of training based on volume of the lab and personnel's training
- ▶ Credentialed Therapist
 - ▶ High volume check-offs done first (nebs, MDI, IS, O2, etc.)
 - ▶ Trained usually by someone who trained someone (water downed effect)
 - ▶ Low volume test

Training Competency and Check-Offs

- ▶ Proposal
 - ▶ Respiratory Student
 - ▶ (PFTs, Sleep, Rehab, etc.) should be taught later in the curriculum, closer to the clinical rotations
 - ▶ More than 2 days of exposure- a lot to digest
 - ▶ Credentialed Therapist
 - ▶ One or two certified trainers (checked off by the PFT Lab)
 - ▶ Rotation thru the PFT for at least 2 weeks
 - ▶ Yearly audits and competency

Training and Competency Check-offs

Graphic Analysis

Spirogram (Volume Time Tracing)

Verifies sharp rise to maximal inspiration			
Verifies smooth curve with gradual tapering on exhalation			
Identifies evidence of glottic closure/abrupt term of flow			
Verifies presence of 1 sec plateau (use of Tiffaneau curve as necessary) if 15 sec FET not met			
Maximal inspiration after emptying (inspiratory peaks match)			

Flow Volume Loop

Expiratory Loop

Verifies sharp rise to peak flow			
Identifies evidence of poor inspiratory effort (flattened loop) or an indication of possible variable intra-thoracic obstruction (lack of taper, abrupt ending to flow)			
Identifies evidence of vocal disturbances, secretions in airway, obstruction of mouthpiece (tongue in mouthpiece) and cough. Can also state how "one second" is identified on FVL.			

Graphic Analysis (cont.) - Flow Volume Loop

	MET	NOT MET	N/A
Inspiratory Loop			
Verifies that volume matches expiratory loop			
Verifies concave appearance (deep bowl)			
Identifies evidence of poor inspiratory effort (flattened loop) or an indication of possible variable extra-thoracic obstruction			

Data Analysis

Data Analysis

Start of Test criteria

Verifies that there is no cough in the first second			
Verifies that EV is acceptable FVC > 2L : EV ≤ 5% FVC < 2L : EV ≤ 0.10L			
Verifies that FET PEF is acceptable (< .12 sec)			

End of Test criteria

Verifies exhalation (1 second plateau or 15 seconds)			
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Subsequent Efforts and End of Session

Modification/coaching as needed to improve testing			
Verifies repeatability (3 valid efforts with FVC and FEV1 within 0.15L of the largest effort ** If max FVC or FEV is < 1.0L, repeatability factor is .10L of the largest effort**			
Identifies when enough efforts have been obtained Max 8 (ATS) or as needed if safe to proceed			
Appropriate Comments (including Med Rec and MDI as needed)			
Can identify evidence of obstruction and restriction			

Notes/Other

Training and Competency Check-offs

POST TEST AUDIT

TECH: _____

DATE OF TEST: _____

MRN: _____

TEST: SPIRO LUNG VOLUMES DLCO METH 6MV/D SAT OTHER

**DID TEST MEET ATS & LAB REQUIREMENTS FOR QUALITY & REPEATABILITY
OR WERE EXCEPTIONS DOCUMENTED APPROPRIATELY?** YES / NO / DISCUSS

IF "NO" WHAT ELEMENTS WERE LACKING OR DEFICIENT?

COMMENTS:

Comments

► Can make or break a testing session.

ATS repeatability standards for spirometry met.

Early termination of expiration and no expiratory plateau.

Very abrupt early termination of expiration; likely to be glottis closure.

Cough in 1st second despite repeated efforts; FEV1 quality is suspect.

Extrapolated volume greater than ATS allows; FEV1 may not be valid.

Time to Peak Flow (FETPEF) higher than lab standard, FEV1 may not be valid.

The patient did not appear to understand spirometry instructions despite repeated attempts.

The two largest FVCs were not repeatable.

The two largest FEV1s were not repeatable.

The flow limitation pattern exhibited on the flow-volume curve was/was not repeatable. Patient effort was/ was not consistent.

Comments

- ▶ **Can make or break a testing session.**
 - ▶ Comments to refrain from using:
 - ▶ Patient did their best
 - ▶ Patient gave poor effort
 - ▶ Patient gave good efforts and cooperation
 - ▶ Patient tried multiple times
 - ▶ And the worst comment of all is NO COMMENT



Tips and Tricks

- ▶ Be animated
- ▶ Power of the cough
- ▶ A punch in the gut
 - ▶ Use analogies
- ▶ Power of competition



Quick Reference Guide

▶ **Spirometry**

▶ **Start of Test Criteria:**

- ▶ No cough in the first second
- ▶ Acceptable EV (back extrapolated volume)
 - ▶ If FVC is $> 2.0\text{L}$ EV must be $< 5\%$
 - ▶ If FVC is $\leq 2.0\text{L}$ EV must be $< 0.10\text{L}$
- ▶ Acceptable FETPEF (time to peak flow): ≤ 0.12 seconds

▶ **End of Test Criteria:**

- ▶ One second plateau or 15 second time limit

▶ **Repeatability**

- ▶ The 2 Largest FVC within 0.15L of each other
- ▶ The 2 Largest FEV1 within 0.15L of each other

Starts and Ends with...

Remember that all breathing test are patient effort dependent.

However, a testing session is only as good as the coach

YOU!!!!!!



"THE MOST DANGEROUS
PHRASE IN THE LANGUAGE
IS 'WE'VE ALWAYS DONE IT
THIS WAY'."

Rear Admiral Grace Hopper

