Spirometry Tracing Review

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Common Spirometry Errors

• Sub-maximal inhalation
• Excessive extrapolated volume
• Sub-maximal blast
• Cough in first second
• Early termination
• Variable effort
More common errors...

- Partially obstructed mouthpiece
- Cessation of airflow – Glottis closure or breath holding
- Extra breaths
- Leak (subject or equipment)
- Positive zero-flow error (equipment)
- Negative zero-flow error (equipment)
**PROBLEM:** Under-reporting of FVC & FEV1 (mimics restriction)

**SOLUTION:** Coach subject to FILL THEIR LUNGS, taking the deepest breath possible

**SPIROMETER ERROR:** “FVC variable”, “FEV1 variable”, or “Take a deeper breath”
Excessive Extrapolated Volume (Slow Start)

PROBLEM: Delayed peak or a slow or hesitating start, resulting in an inaccurate FEV1
SOLUTION: Coach the subject to blast FASTER and SOONER!
SPIROMETER ERROR: “Hesitation”, Large extrapolated volume”, or “Start Faster”
Forced Expiratory Volume in 1 Second (FEV$_1$)

Back Extrapolation Technique

Increased back extrapolation volume will yield a falsely high FEV1.
Back Extrapolation

Flow/Volume

Flow (l/s) vs. Volume (L - BTPS)
**PROBLEM:** Poor blast effort resulting in an inaccurate FEV1
**SOLUTION:** Coach subject to blast the air out harder.
**SPIROMETER ERROR:** “Blast out harder” (Caution: Some spirometers may not label these as errors)
Variable Peaks

A - Good blast effort (lower FEV1)

B - Poor blast effort (higher FEV1)

Report the FEV1 from “A” even though it is lower.
Cough in first second

PROBLEM: Drop in flows during the 1st second causing an inaccurate FEV1 measurement—either falsely high or falsely low

SOLUTION: Offer subject a drink of water

SPIROMETER ERROR: “Avoid Coughing”
Early Termination

PROBLEM: Quit maneuver too soon resulting in a falsely reduced FVC and invalid FEV1/FVC%  
SOLUTION: Coach subject to keep blowing longer.  
SPIROMETER ERROR: “Early termination” or “Keep blowing”  
(Caution: Some spirometers may not label these as errors)
Acceptable Test

(<6 seconds with an obvious plateau)

In this example spirometer error messages about “early termination” or “unacceptable test” should be ignored.
Variable Effort

**PROBLEM:** Exhaled airflow varies; often seen as a dip on the F/V curve.

**SOLUTION:** Coach the subject to blast out one breath hard & fast with proper placement of the mouthpiece.

**SPIROMETER ERROR:** Most spirometers will not label this as an error.
PROBLEM: Mouthpiece is partially blocked by the teeth, tongue, loose dentures, or strong biting that deforms the shape.

SOLUTION: Re-explain the proper placement of the mouthpiece.

SPIROMETER ERROR: Most spirometers will not label this as an error.
Denture problem or tongue in mouthpiece
Improper mouthpiece placement
Cessation of Airflow
Glottis Closure or Breath Holding

PROBLEM: Airflow suddenly ceases before the subject is empty causing the FVC to be falsely reduced.

SOLUTION: Coach the subject to “blow until your lungs are COMPLETELY empty” Keep chin up!

SPIROMETER ERROR: “Blow out longer” or “Abrupt end”
Early termination or glottis closure
Early termination or glottis closure
**PROBLEM:** Subject takes extra breaths through nose or mouth near or at the end of the maneuver (over-estimating the FVC)

**SOLUTION:** Use noseclips or remind subject to keep a tight seal around the mouthpiece (delete invalid maneuvers)

**SPIROMETER ERROR:** Spirometers do not label this error.
#1
(without noseclip)

Delete maneuver #1!

#2
(with noseclip)
PROBLEM: A leak in the spirometer, hose, or around the subject’s mouthpiece.

SOLUTION: Perform a leak check if using a volume spirometer. Check tubing if using a flow spirometer. Also, check for tight lip seal.

SPIROMETER ERROR: Spirometers do not label this error.
Sensor Drift (Negative zero-flow error)

**PROBLEM:** Downward drift on the V/T tracing (looks similar to a leak in a volume spirometer.) Occurs when air is moving in the same direction as the patient’s exhalation during the zero process.

**SOLUTION:** Re-zero the sensor, occluding the sensor; delete invalid maneuvers.

**SPIROMETER ERROR:** Spirometers do not label this error.
Negative sensor drift
Sensor Drift (Positive zero-flow error)

**PROBLEM:** The zero flow reference point is set incorrectly due to air moving through the pneumotach during the zero process.

**SOLUTION:** Occlude sensor during zeroing process. Delete maneuvers with invalid volume.

**SPIROMETER ERROR:** Spirometers do not label this error.
Positive Sensor Drift
Sensor drift on all maneuvers
An inaccurate zero obtained at the start of the test session will make all the efforts invalid.

**Zero Error**
- FVC = 4.94 L, 120% pred
- FEV1 = 2.64 L, 79% pred
- FEV1/FVC = 0.53

**Valid Test**
- FVC = 3.67 L, 90% pred
- FEV1 = 2.42 L, 73% pred
- FEV1/FVC = 0.66
Blocked or contaminated sensor
Delete invalid maneuvers

<table>
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<tr>
<th>Obs</th>
<th>%Pred</th>
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<tbody>
<tr>
<td>FVC</td>
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<tr>
<td>FEV&lt;sub&gt;1&lt;/sub&gt;</td>
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<tr>
<td>PEF</td>
<td>15.9</td>
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Repeatability $>0.15\,L$, FVC, FEV<sub>1</sub>, PEF elevated
Sensor lines reversed
“Floppy airways”

Ask subject to relax their throat when blowing.
“Redundant tissue of the upper airway”
“Knee”

Normal variant; often seen in non-smokers, esp. women.
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Questions