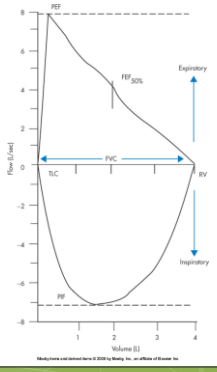
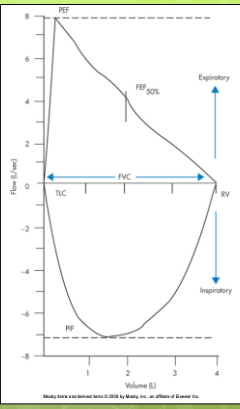
1

Spirometry

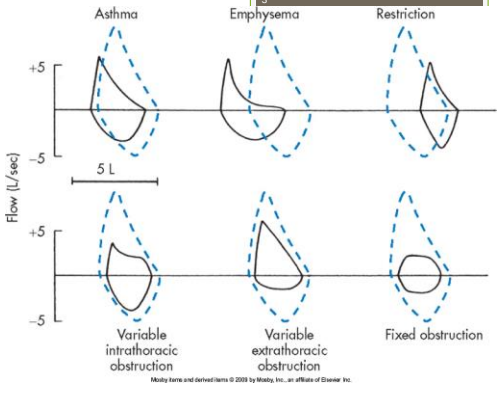
- By Helen Grim M.S. RRT



2



3



4

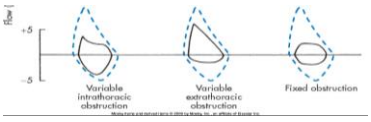
Obstruction

- loop will have concave appearance.
- Flows decreased consistent with degree of obstruction.
- Volumes may be normal, but can **decrease with severity** of obstruction causing air trapping. (FVC vs SVC)

5

Obstruction cont….

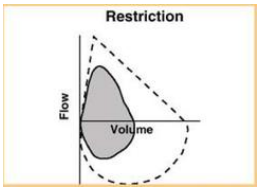
- Variable intrathoracic, affects expiratory flows
- Variable extrathoracic: affects inspiratory flows.
- Fixed obstruction affects both



6

TYPICAL RESTRICTION

- Simple restriction: curve is miniature of normal.
- Reduced VC
- Normal or increased FEV_1/FVC ($FEV_1\%$)
- Increased elastic recoil of fibrotic lungs allows for increased flows.
- TLC is reduced in restriction… lung volume measurement is important
- Most often does not respond to bronchodilator.



7

Combined restriction/obstruction

- Patients may exhibit characteristics of both:
- Reduced volumes (**confirmed by LV measurement**) which don't improve
- Also reduced flows which may or may not improve.

8

BASIC INTERPRETATION

% of predicted	**FVC, and FEV_1**
80-100%	Normal
> 70%	mild
60-69%	Moderate
50-59%	moderately severe
35-49%	Severe
< 35%	very severe

9

FEV_1/FVC or FEV_1%

- The FEV_1% compares the amount of gas exhaled in the first second to the total amount exhaled.
- Normal adult lungs can exhale **~75%** of its FVC in the first second.
- What would it indicate if the FEV_1% was 50%?
- What would it indicate if the FEV_1% was 85%?

11

Basic Interpretation

- Look at the FEV_1% ratio first if obstruction is suspected. If the FEV_1% ratio is lower than expected (the lower limit of normal), obstruction is present.
- If the ratio is normal or elevated, check the percent predicted for FVC and FEV_1. If FVC and FEV_1 are both reduced compared with the expected values, and FEV_1% is normal or high, restriction or muscle weakness may be present.

12

Interpretation: Response to bronchodilator

- Bronchodilators often administered to determine reversibility of obstruction.
- An increase of **12% or greater in FEV_1** is considered POSITIVE response to meds or **200ml improvement in FVC**
- Good med technique and appropriate wait time are important. 10-15 minutes for SABA

15

Lung Volumes

- Tidal volume (V_T) - the volume from resting expiration to resting inspiration. **Normal ~ 0.5L**
- Inspiratory Reserve Volume (IRV) - the volume from resting inspiration to maximal inspiration. **Normal ~ 3.1L**
- Expiratory Reserve Volume (ERV) - the volume from resting expiration to maximal expiration. **Normal ~ 1.2L**
- Residual Volume (RV) - the volume left in the lungs after maximal expiration. **Normal ~ 1.2L**

16

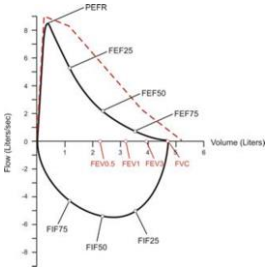
Lung Capacities

- Inspiratory Capacity (IC) = V_T + IRV Normal ~ 3.6L
- Vital Capacity (VC) = V_T + IRV + ERV OR IC + ERV Normal ~ 4.8L
- Functional Residual Capacity (FRC) = ERV + RV Normal ~ 2.4L
- Total Lung Capacity (TLC) = sum of all volumes

17

Flowrates

- FEV_T
  - the volume of exhaled gas in a defined number of seconds from the start of an FVC maneuver
  - Four variants: FEV 0.5, 1, 2, & 3 seconds
  - often reported only in mL or liters because the volume referred to is measured in a known amount of time– but because this is ΔV/ΔT, it is actually a flowrate



18

Peak Flow

- normal ~ 10L/sec or 600 L/min
- is the maximal flowrate attainable at any time
- on spirographic tracing, is measured as the tangent to the steepest slope of the spirogram
- absolute accuracy is poor but good for "trend monitoring"

19

Forced Expiratory Flow 200-1200 ($FEF_{200-1200}$)

- aka MEFR (Mean Expiratory Flowrate)
- normal ~ 400L/min
- is the average flowrate after the initial 200mL is exhaled
- a more reliable index of airway's condition (rather than patient effort)
- tends to be sensitive (↓ values) to obstruction of the larger airways

20

Forced Expiratory Flowrate from 25% - 75% of volume ($FEF_{25\%-75\%}$)

- aka Maximum Mid-expiratory Flowrate (MMFR)
- normal ~ 282L/min
- represents the average flow during the middle 50% of exhalation during the FVC maneuver
- a very reliable index of:
  - obstruction in medium to small airways (these are the sites most affected by asthma) or
  - chronic secretion diseases (e.g., chronic bronchitis and cystic fibrosis)

21

Practice

	Meas.	Predicted	%Predicted
FVC	1.33L	3.38L	39%
FEV_1	1.21L	2.36L	51%
FEV_1/FVC aka $FEV_{1\%}$	91%		

22

Practice

	Pre	Pred.	%	Post	%
FVC	2.30L	3.63L	**63**	2.45	**67 (+4%)**
FEV_1	1.12L	2.57L	**44**	1.30	**51 (+7%)**
$FEV_{1\%}$	**49**	75%		53	
$FEF_{25\%-75\%}$	0.59LPS	2.38LPS	**25**	0.83LPS	**35 (+10%)**

Volumes	Pre	Pred.	%
VC	2.50L	3.63L	**69**
FRC	3.99L	2.80L	**142**
RV	3.13L	1.91L	**164**
TLC	5.79L	4.82L	**120**
RV/TLC	**54%**	40%	

34

References

- Brusasco, V., Crapo, R., Veigi, G. (2005) General Considerations for Lung Function Testing. European Respiratory Society Journal DOI: 10.1183/09031936.05.00034505
- Mottram, C.D. (2013) *Ruppel's Manuel of Pulmonary Function Testing*. Maryland Heights, MO: Elsevier Mosby