What RTs should know about PFTs

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What RTs should know about PFTs

Objectives:

- To recommend appropriate tests to identify specific lung conditions.
- To describe the difference between FRC and Vtg.
- To list indications for diffusion testing.
- To discuss the difference between PFTs done in the lab versus the ICU.
- To review CPET

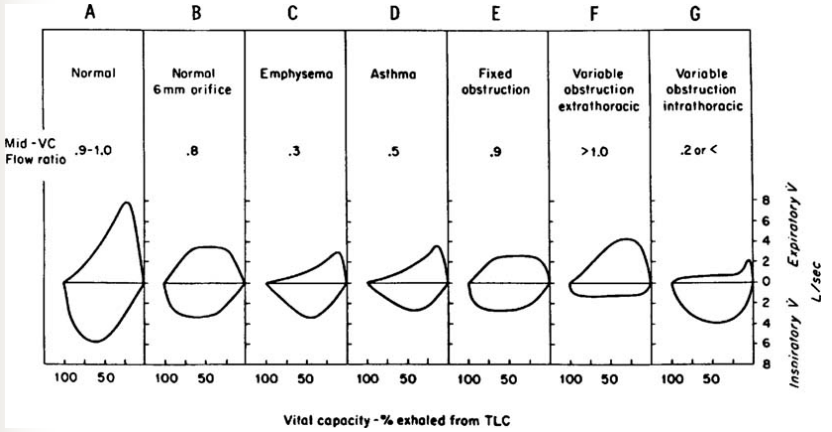
Aversion therapy for smoking cessation

"That's the third smoker we've lost this week."

Direct volume measurements

- FVC and SVC
- FVL
- Capacities (IC and VC)

Direct volume and flow measures



Indirect volume measurements

Helium dilution, Nitrogen washout (single and multiple breath), Body box

Measurements for FRC

- (RV=FRC-ERV)

closed circuit method

- Helium dilution- start at FRC

- Initial He volume = Final He volume, measure He% change

(FinHe)(FRC)+(FinHe)Vs=(FfinHe)FRC+Vs

Where: in = initial, fin=final, s=spirometer

open circuit method

- Nitrogen washout- breath 100% O2
- 7 min. normal w.o. time stop when < 2% N2.
- FRC= N2 (ml)/0.80 collected

Monitoring FRC in Ventilated Patients

Alexander Adams RRT, MPH, FAARC

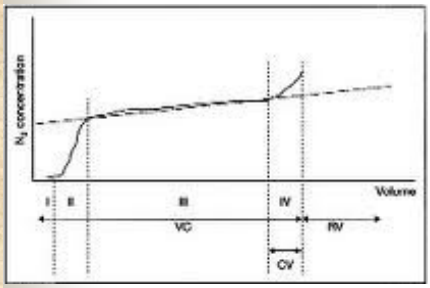
- www.critical-decisions.org/
- Continuing Education for Dietitians (CPE) and Respiratory Therapists (CRCE)
- Functional Residual Capacity (FRC) is a measurement of the reservoir of air that keeps lungs oxygenated after a normal exhalation. In mechanically ventilated patients, FRC measures actual lung volume. Although FRC is a vital indicator of acute lung pathology, until recently, FRC could not be measured…….

Recognize a single-breath N2 elimination test for CV.

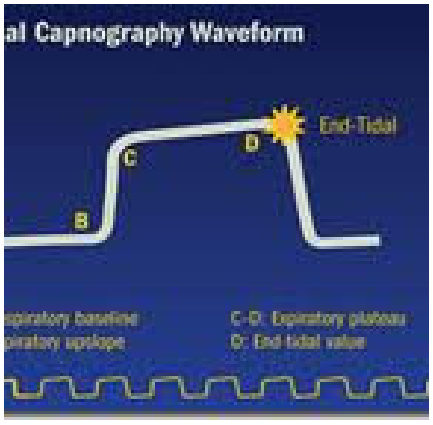
- Compare to end tidal CO2 waveform.
- Closing volume
- Small airway disease
- CV = phase IV % of VC
- CC = CV + RV
- Distribution of vent. Related to slope of Phase III

Exhaled Gas waveforms

Single breath N2



Single breath CO2



body box

- Body plethysmographs - who's law?
- Patm (ΔV/ΔP)
- P1V1=P2V2
- Vtg (thoracic gas volume)
- airway resistance (Raw)

Measuring Raw and Gaw in the box

- Raw=(PA/Pbox)/(V/Pbox)Xcal factor
- V=airflow
- PA=alveolar pressure
- Pbox= plethysmograph pressure

Note: Advantage over FVC for detection of obstruction is not effort dependent. "Most sensitive method for detecting aw disease."

Patient preparation for DLCO:

- No smoking for 24 hrs;
- No alcohol for 4 hrs;
- No food for 2 hrs,
- No strenuous exercise,
- No supplemental O2 for 20 min. Prior.

Indication for diffusion testing

- Follow progress of parenchymal disease
- Evaluate involvement of systemic diseases (rheumatoid arthritis, sarcoidosis, lupus, sclerosis)
- Evaluate COPD
- Evaluate cardiovascular disease, L-R shunt
- Quantify disability
- Pulmonary hemorrhage, Hb

Calibration, QC, Accreditation

- Calibration documentation
- Quality control program
- ATS/ERS guidelines
- No Accreditation system

Pulmonary Mechanics Testing

Review resistance (Raw, Gaw), compliance, work of breathing, MIP, MEP, Review FVC measures

Formula for Resistance?

- Raw = Atm. Pres-Alv. Pres/flow
- units
- 50% upper airway
- 30% trachea and bronchi
- 20% small airways

Formula for Conductance?

- 1/Raw
- L/sec/cmH2O
- Sgaw= Gaw standardized for flow and volume.

Normal values

- Raw = 0.6 to 2.4 cmH2O/L/sec.
- How much pres it takes to push flow through the airways.
- Gaw = 0.42 to 1.67 L/sec/cmH2O
- As Raw goes up Gaw goes down.
- Sgaw = 0.10 to 0.15 L/sec/cmH2O

(Normalized for flow of $\pm$0.5 L/sec and specific volume)

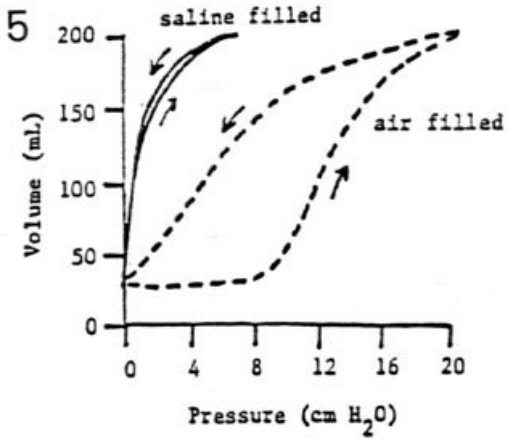
Compliance: Lung; Chest wall; Total

- C = change in volume / change in pressure

What is hysteresis ?

- The difference between the inflation and deflation curve of the lung. (See graph)

Hysteresis curve



MIP ?

- From maximum *"exhalation"*
- Normal at least - 60 cmH2O
- Record at least 3 good efforts
- Report best effort reproducible ± 10% or 10cmH2O

Work of breathing:

Work = force x distance

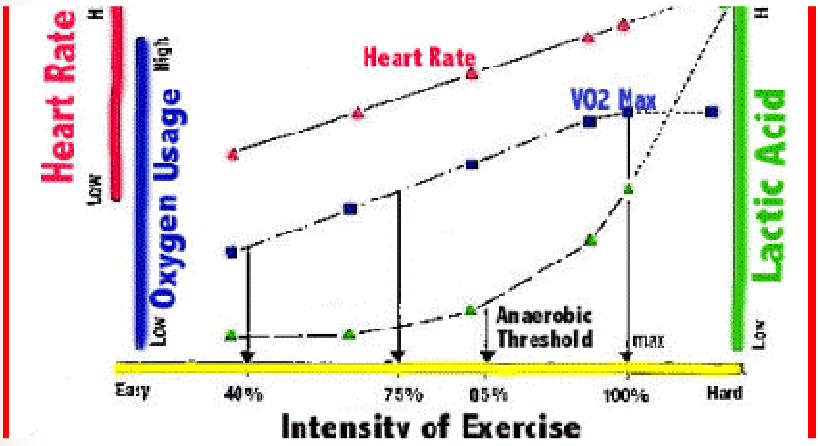
WOB = P x V

WOB = change in pressure x change in volume

Indications for Exercise Testing

- Determine the level of cardiorespiratory fitness
- Diagnose exercise limitation as a result of fatigue, dyspnea, or pain
- Evaluate exercise desaturation
- Assess preop. Lung surgery risk
- Assess occupational lung disease disability
- Evaluate heart and lung transplants

Oxygen consumption vs. work



Indications for ending tests

- General
- Normal reaction
- Clinical signs and symptoms of distress
- Signs of hypoxemia
- ECG signs of distress
- Blood pressure signs

Indices of exercise testing

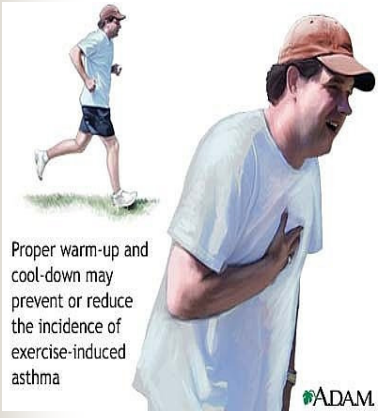
- O2 pulse
- HRR
- BR or VR
- Dyspnea index
- MET
- Ventilatory equivalents for O2 or CO2

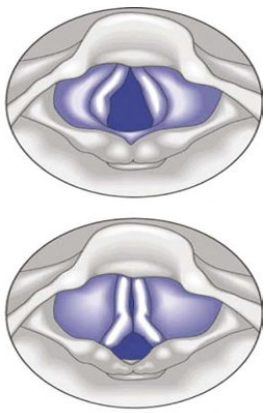
Weber's Classification of Functional Impairment. from Weber, et al. Circulation 65:1213-1223, 1982.

Class	Severity	VO2max (ml/kg/min)	AT(VO2max ml/kg/min)
A	Mild to none	>20	>14
B	Mild to mod.	16-20	11-14
C	Mod. to severe	10-16	8-11
D	severe	6-10	5-8
E	Very severe	<6	<4

Flow limitations

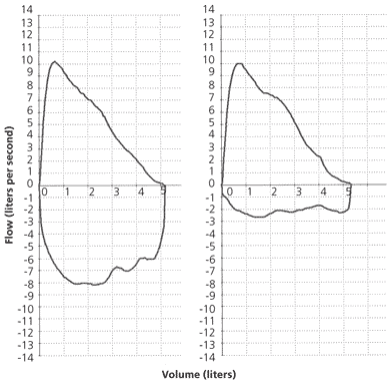
EI



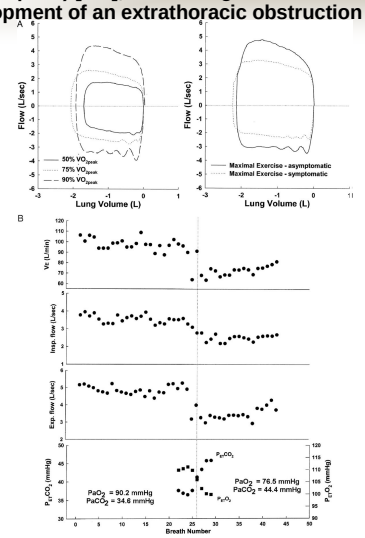


VCD (vocal cord dysfunction)

Inspiratory flow limitations (extrathoracic) caused by vocal cord dysfunction VCD



Top, A: tidal flow-volume loops (FVLs) obtained during exercise at 50%, 75%, and 90% of peak oxygen uptake (V̇O2peak) [left], and during maximal exercise before and after the development of an extrathoracic obstruction (right).



Dempsey J A et al. Chest 2008;134:613-622

Potential contraindications to PFT

- Patient with poor coordination,
- severe dyspnea,
- the very old,
- the very young, and
- those who cannot follow instructions make poor candidates,
- Patients with severe asthma, may require modification to protocols.

Other potential contraindications to PFT

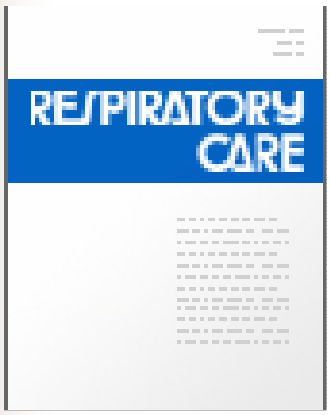
- Patients with aneurisms,
- hernias,
- pulmonary emboli,
- Some arrhythmias may not be candidates.
- Patients with contagious diseases like tuberculosis.

Pediatric testing

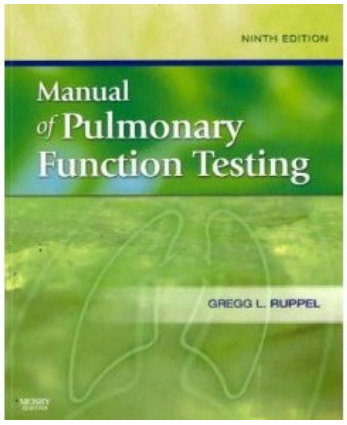
- Effort dependent tests are a problem.
- Lack of predicted values
- Chest and abdominal hugger-(RTC (rapid thoracoabdominal compression) or squeeze) sedation may be necessary
- PEFV (partial expiratory flow-volume curve)

Additional Resources and References

Respiratory Care Journal



Ruppel



In Summary PFT is useful in:

- Evaluating lung disease
- Measuring the effects of medication
- Evaluating mechanical ventilation
- Evaluating the response to exercise