PULMONARY FUNCTION TESTING

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PULMONARY FUNCTION TESTS CATEGORIES

- Spirometry
- Lung volumes (TLC/ RV)
- Diffusing capacity tests
- Blood gases and gas exchange tests
- Cardiopulmonary exercise tests
- Metabolic measurements

INDICATIONS FOR SPIROMETRY

Diagnosis

- To evaluate symptoms, signs, or abnormal laboratory test results
- To measure the physiologic effect of disease or disorder
- To screen individuals at risk of having pulmonary disease
- To assess preoperative risk
- To assess prognosis

Monitoring

- To assess response to therapeutic intervention
- To monitor disease progression
- To monitor patients for exacerbations of disease and recovery from exacerbations
- To monitor people for adverse effects of exposure to injurious agents
- To watch for adverse reactions to drugs with known pulmonary toxicity

Disability/impairment evaluations

- To assess patients as part of a rehabilitation program
- To assess risks as part of an insurance evaluation
- To assess individuals for legal reasons

Other

- Research and clinical trials
- Epidemiological surveys
- Derivation of reference equations
- Pre-employment and lung health monitoring for at-risk occupations

Relative Contraindications for Spirometry

Due to increases in myocardial demand or changes in blood pressure

- Acute myocardial infarction within 1 wk
- Systemic hypotension or severe hypertension
- Significant atrial/ventricular arrhythmia
- Noncompensated heart failure
- Uncontrolled pulmonary hypertension
- Acute cor pulmonale
- Clinically unstable pulmonary embolism
- History of syncope related to forced expiration/cough

Due to increases in intracranial/intraocular pressure

- Cerebral aneurysm
- Brain surgery within 4 wk
- Recent concussion with continuing symptoms
- Eye surgery within 1 wk

Due to increases in sinus and middle ear pressures

- Sinus surgery or middle ear surgery or infection within 1 wk

Due to increases in intrathoracic and intraabdominal pressure

- Presence of pneumothorax
- Thoracic surgery within 4 wk
- Abdominal surgery within 4 wk
- Late-term pregnancy

Infection control issues

- Active or suspected transmissible respiratory or systemic infection, including tuberculosis
- Physical conditions predisposing to transmission of infections, such as hemoptysis,
- significant secretions, or oral lesions or oral bleeding

Confounding factors

- Smoking within 1 h of testing
- Consuming alcohol within 4 h of testing
- Vigorous exercise within 30 min of testing
- Tight clothing
- Large meal within 2 h of testing
- Chest or abdominal pain
- Pain in mouth or face
- Stress incontinence
- Dementia or confessional state

Complications

- Chest pain
- Syncope, dizziness
- Increased ICP
- Paroxysmal coughing
- Bronchospasm
- Nosocomial infection

Hygiene & infection control

- Hand washing
- Gloves
- Disposable mouth piece & nose clip
- Disinfection or sterilization of reusable mouth piece
- Extra precautions for patient with infection

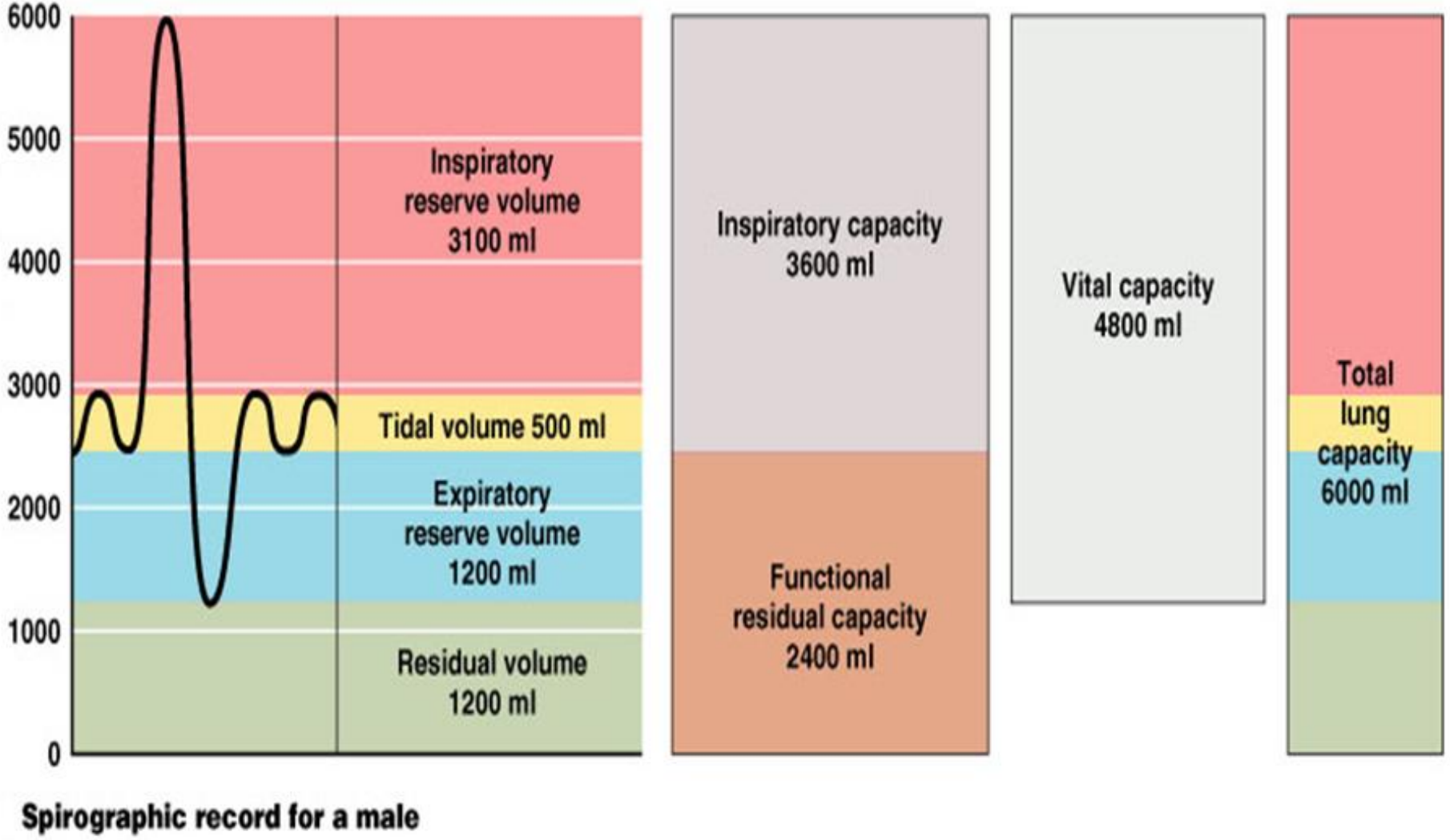
Respiratory Volumes

- **Tidal Volume:** Amount of air moved in and out of lungs during normal breathing
- **Inspiratory Reserve Volume:** Amount of air inspired over normal tidal inspiration at maximal effort
- **Expiratory Reserve Volume:** Amount of air expired over normal tidal expiration at maximal effort
- **Residual Volume:** Air left in lung after maximal expiration

Respiratory Capacities

- Functional Residual Capacity: ERV+RV
- Inspiratory Capacity: TV+IRV
- Vital Capacity: IRV+TV+ERV
- Total Lung Capacity: VC+RV

LUNG VOLUMES & CAPACITIES

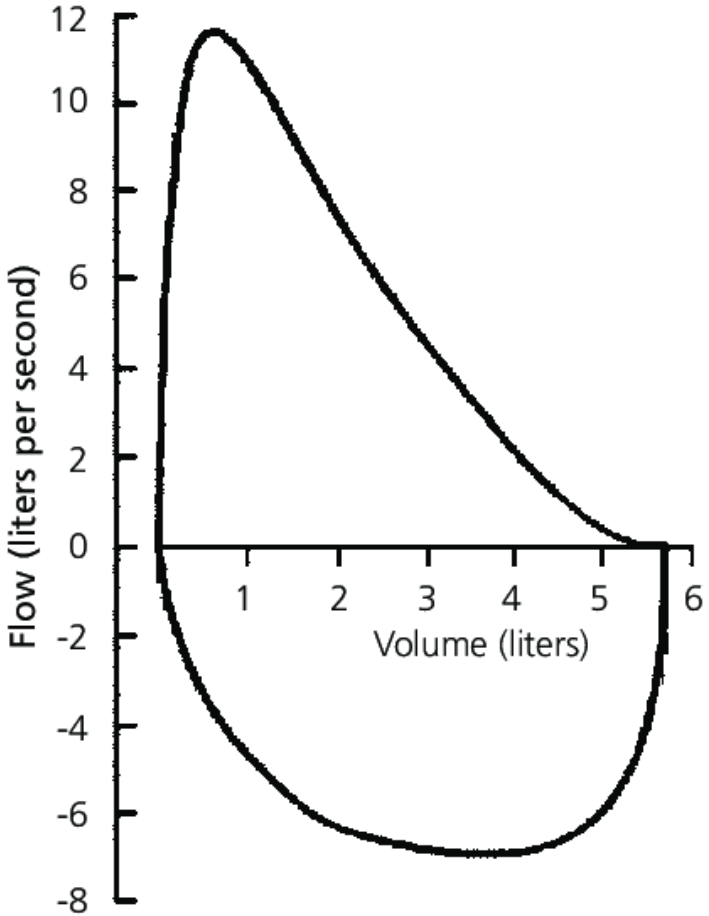


Spirographic record for a male

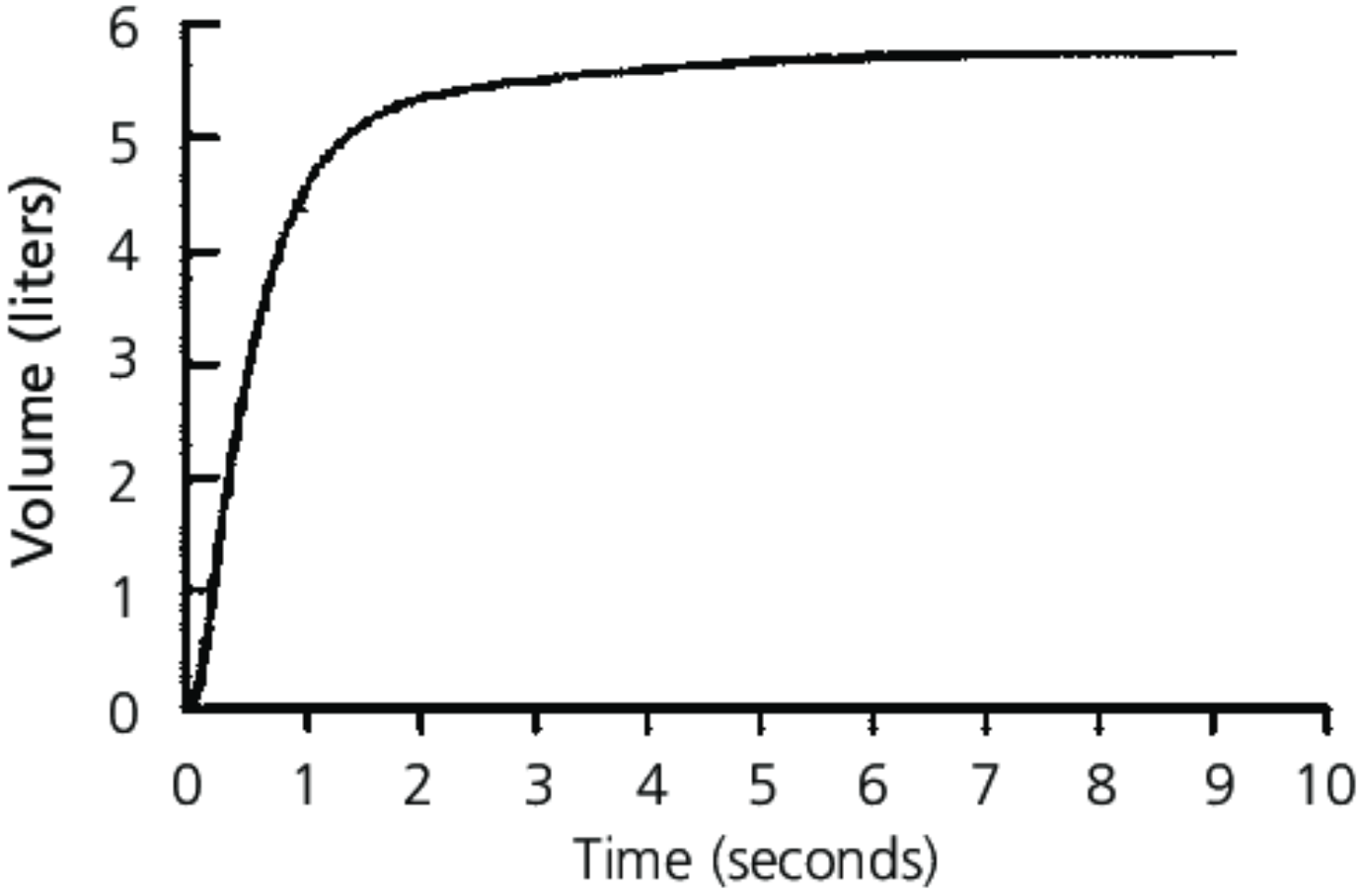
Type of spirometer

- Volumetric spirometer
- Flow-type spirometer

Flow – Volume Curve



Volume - Time Curve



Spirometric values

- FVC (forced vital capacity)
- FEV1 (forced expiratory volume in 1 s)
- FEV1/FVC
- FEF25-75 (maximum midexpiratory flow)
- FEVt (forced expiratory volume in t s)
- PEF (peak expiratory flow)

Spirometry Steps

- Equipment performance criteria
- Equipment validation
- Subject maneuvers
- Acceptability
- Repeatability
- interpretation

Technical Sources of Variation in Lung Function

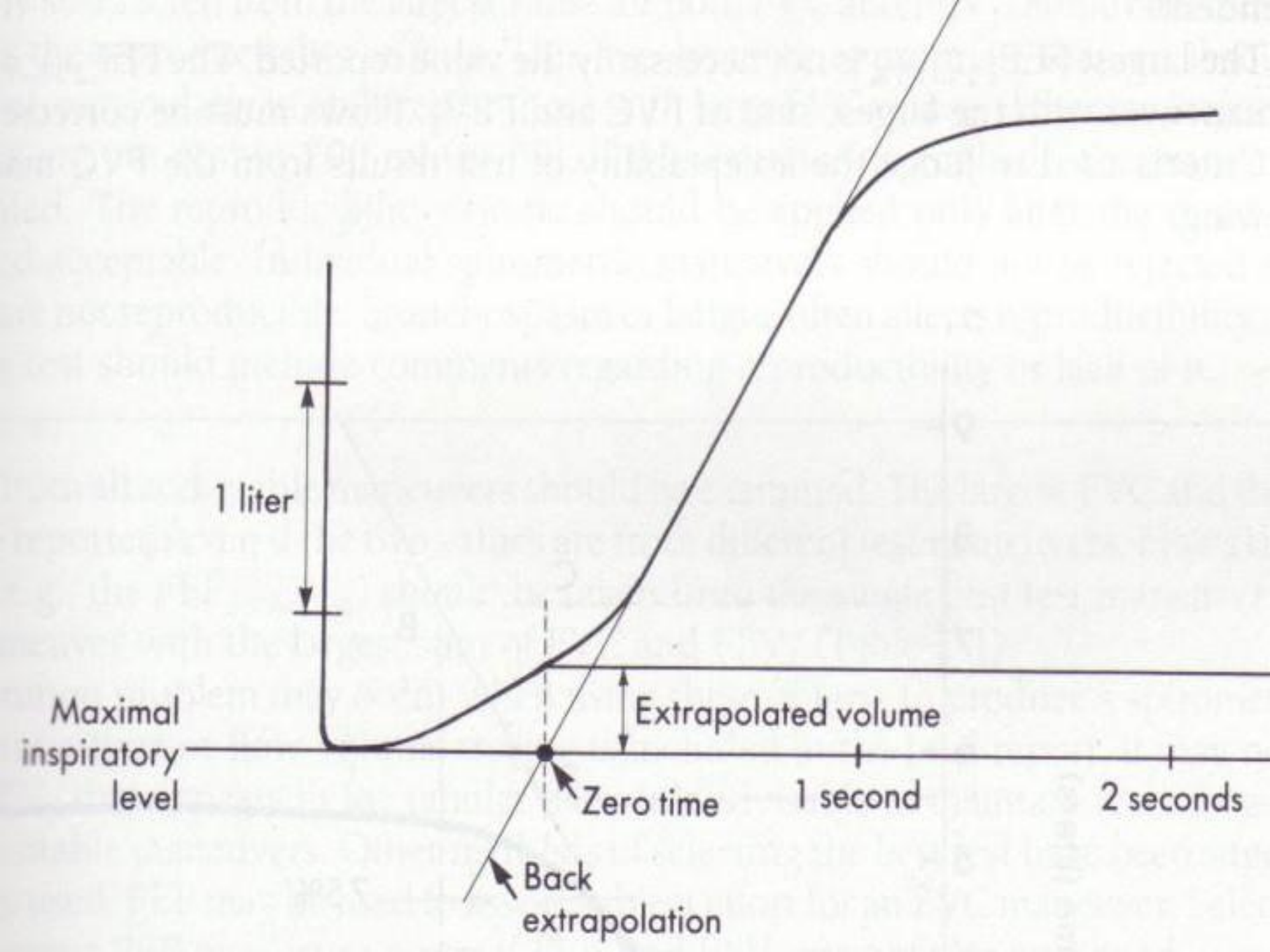
- Instrument (Precision and Accuracy)
- Effort
- Posture (body and head position)
- Observer
- Procedure (including number of tests)
- Software (calculation and feedback)
- Temperature
- Altitude

Biologic Sources of Variation in Lung Function

- Diurnal variation
- Seasonal effects
- Endocrinologic effects
- Personal factors
- Environmental factors
- Occupation factors

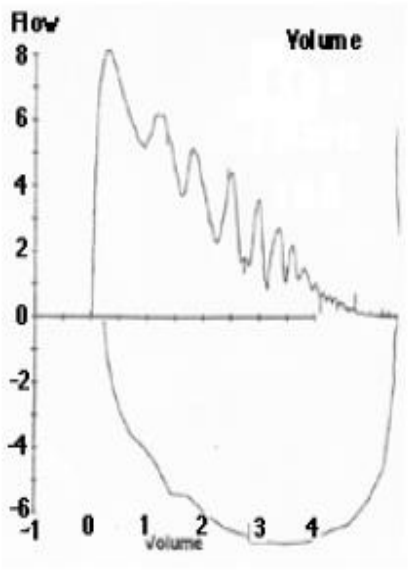
Within Maneuver Acceptability Criteria

- Extrapolated volume< 5% or 100cc
- Hesitation time <2s
- Cough especially during first second
- End of forced expiration criteria (1s plateau or FET of 15s or repeatable)
- Valsalva maneuver (glottis closure)
- FIVC-FVC < 5% or 100cc
- Leak from the mouth
- Obstruction of the mouthpiece
- Extra breath during the maneuver

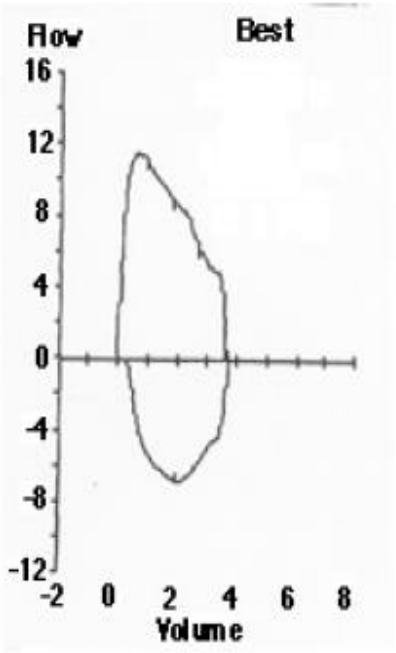

1 liter
Maximal inspiratory level
Extrapolated volume
Zero time
1 second
2 seconds
Back extrapolation

Unacceptable Maneuvers

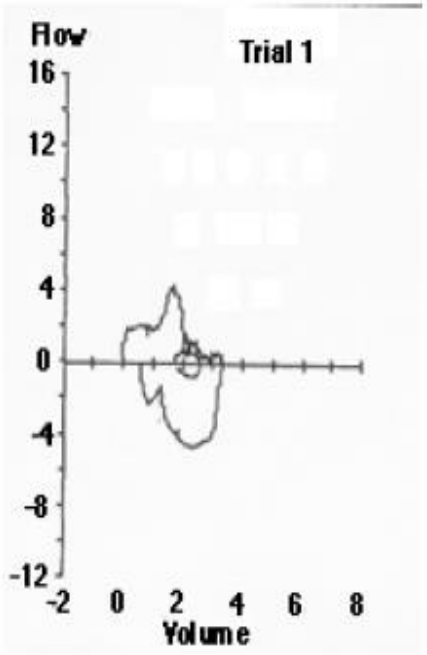
Cough



Early glottic closure



Variable effort

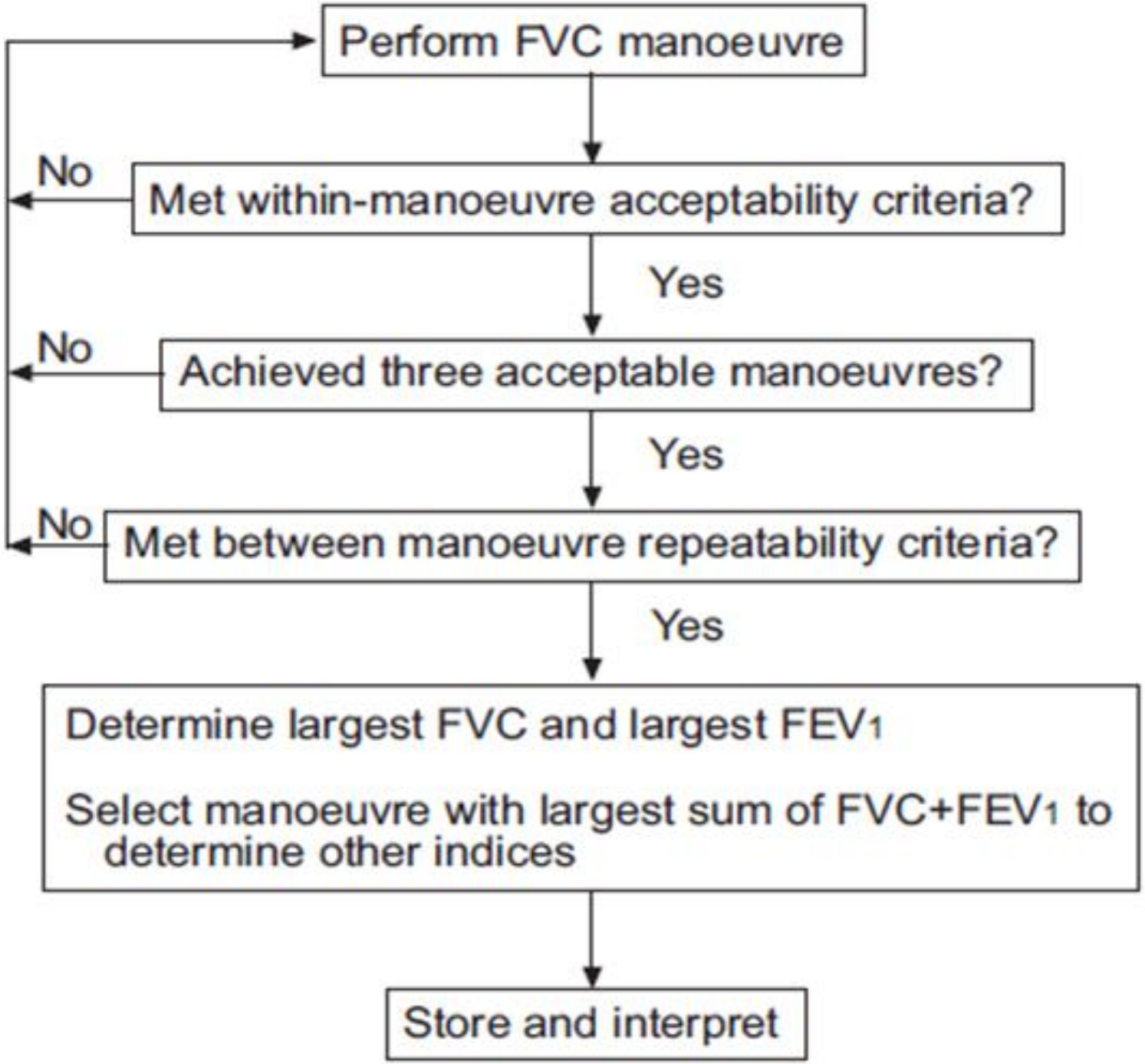


Between Maneuver Acceptability Criteria

- Three acceptable spirograms
- Two largest FVC within 0.150 L of each other
- Two largest FEV1 within 0.150 L of each other
- A total of eight tests

  or

- The patient cannot or should not continue


Perform FVC manoeuvre
No
Met within-manoeuvre acceptability criteria?
Yes
No
Achieved three acceptable manoeuvres?
Yes
No
Met between manoeuvre repeatability criteria?
Yes
Determine largest FVC and largest FEV1
Select manoeuvre with largest sum of FVC+FEV1 to determine other indices
Store and interpret

Are these results below the "lower limit of normal?"

Interpretation

Predicted value & lower limit of normal (LLN)

- Fifth percentile: the point below which 5% of normal subjects fall.

FEV1 and FVC = 80%

FEV1/FVC = 70-75%

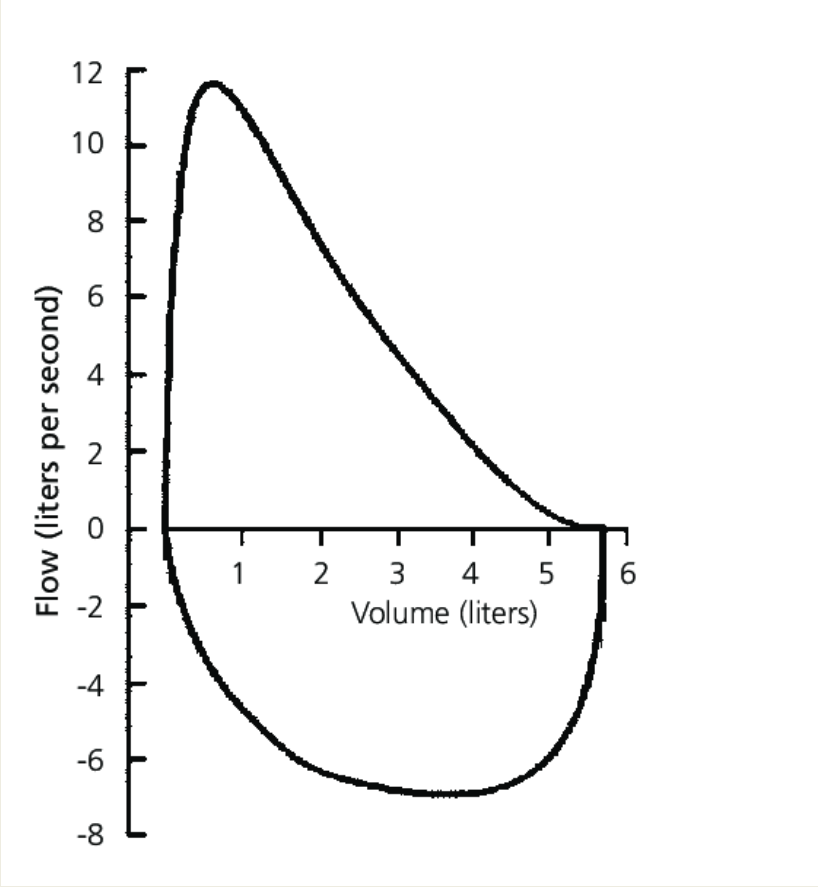
FEF25-75 = 50-60%

LLN for male with 175cm height

Age	FVC	FEV1	FEV1/FVC	FEF25-75
20	83%	83%	74%	68%
40	82%	81%	70%	60%
60	80%	78%	66%	46%
80	76%	72%	62%	18%

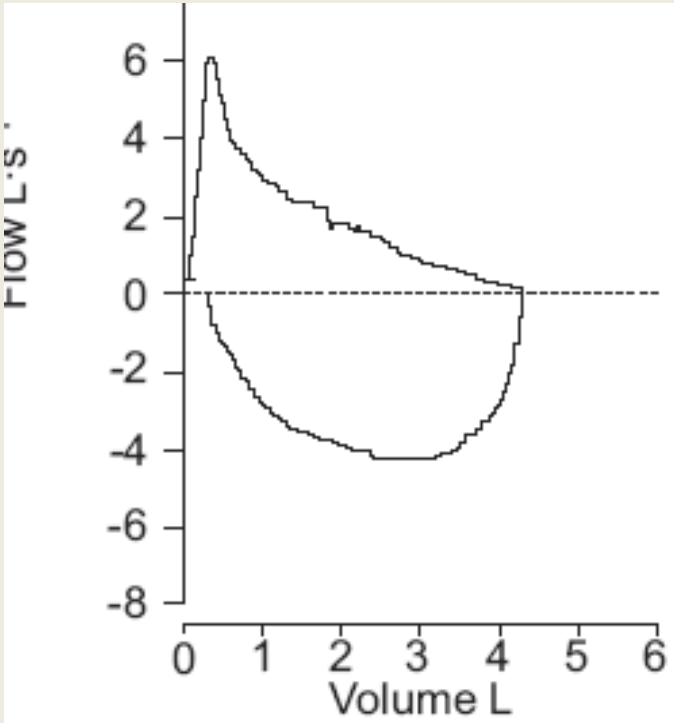
Normal Spirometry

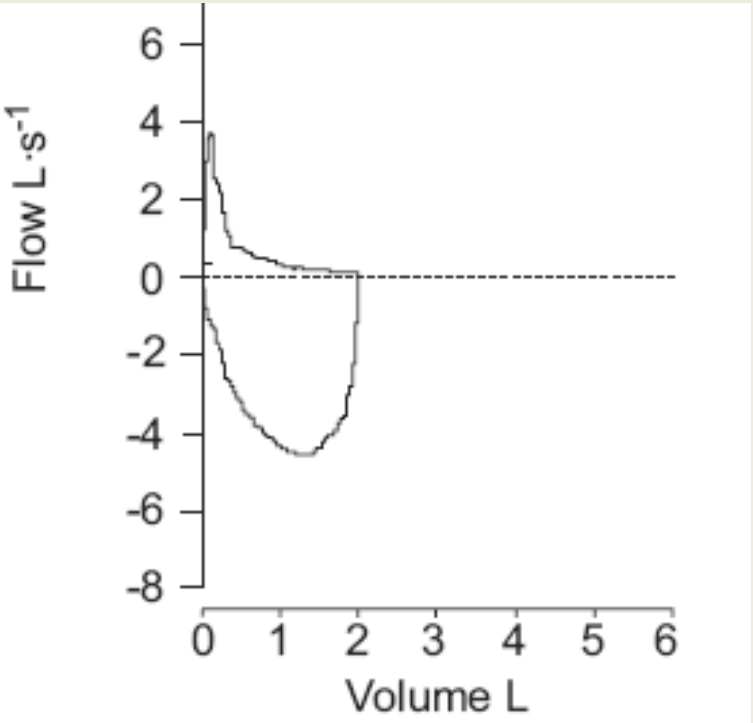
Both the FVC and the FEV1/VC ratio are normal.



Obstructive Spirometry

Normal or low FVC, Low FEV1 & FEV1/FVC

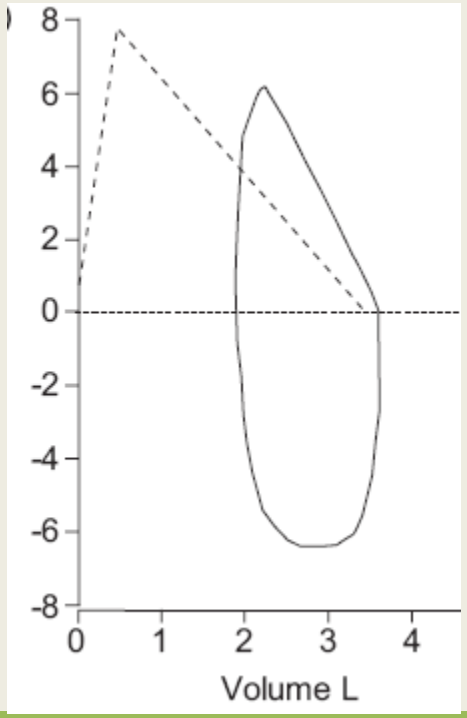




Restrictive Spirometry

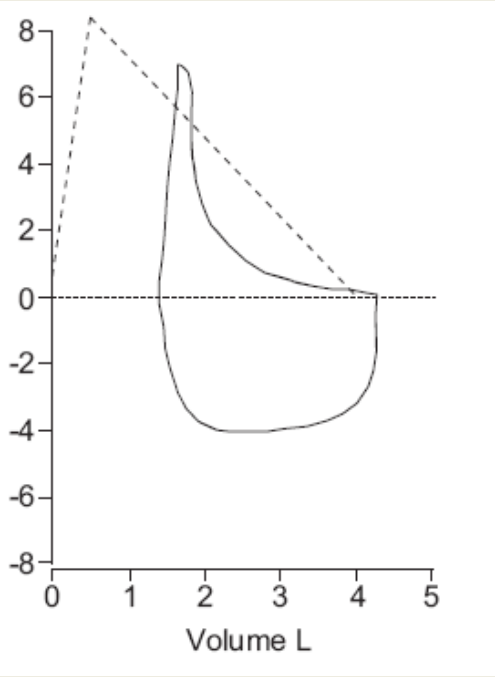
Low FVC & FEV1, Normal or high FEV1/FVC

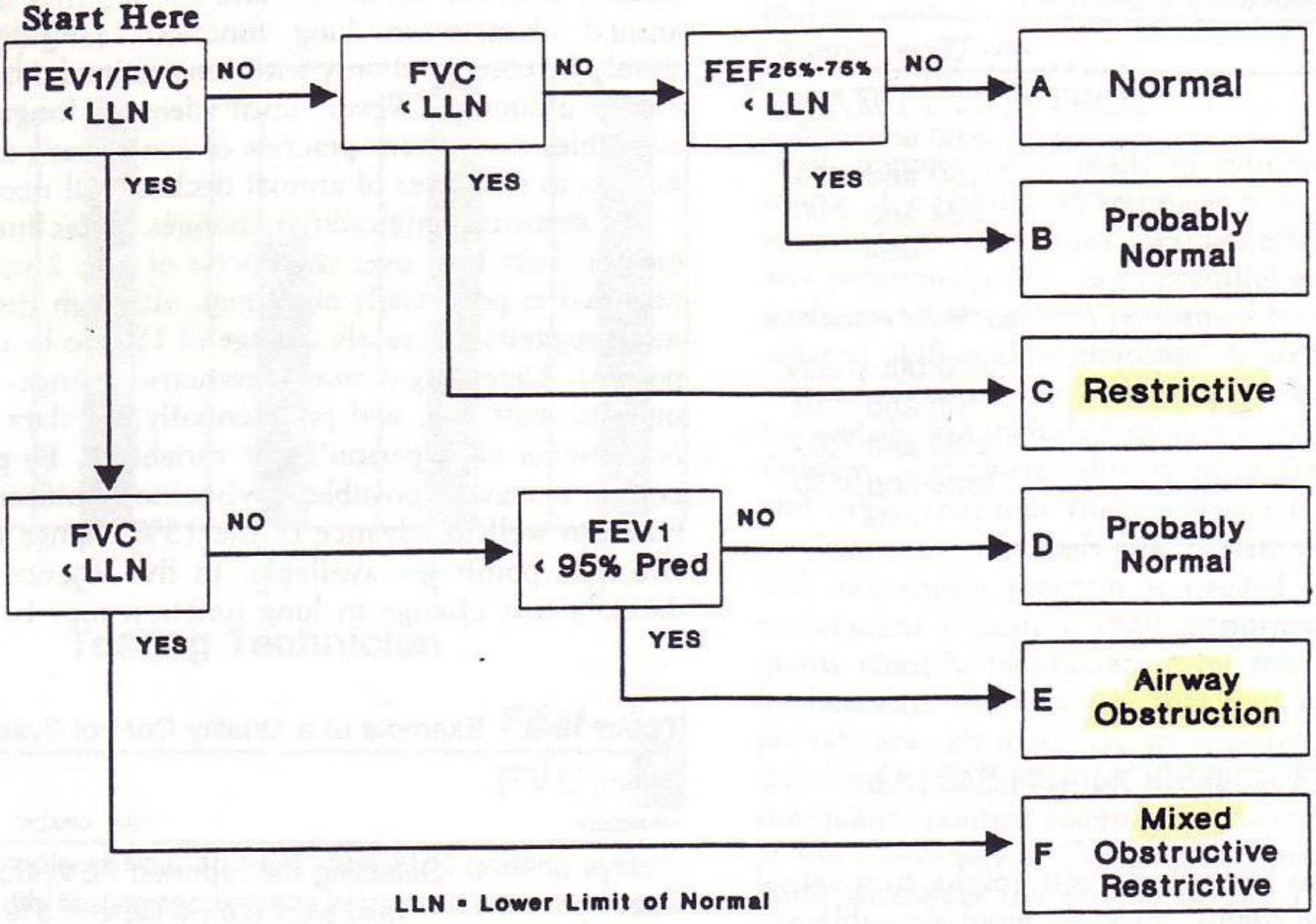
(TLC & RV should be measured)



Mixed pattern Spirometry

Low FEV1, FVC, FEV1/FVC





Interpretation Statements for Spirometry

The Severity of the Abnormality

% Pred FEV1 > 80 Normal

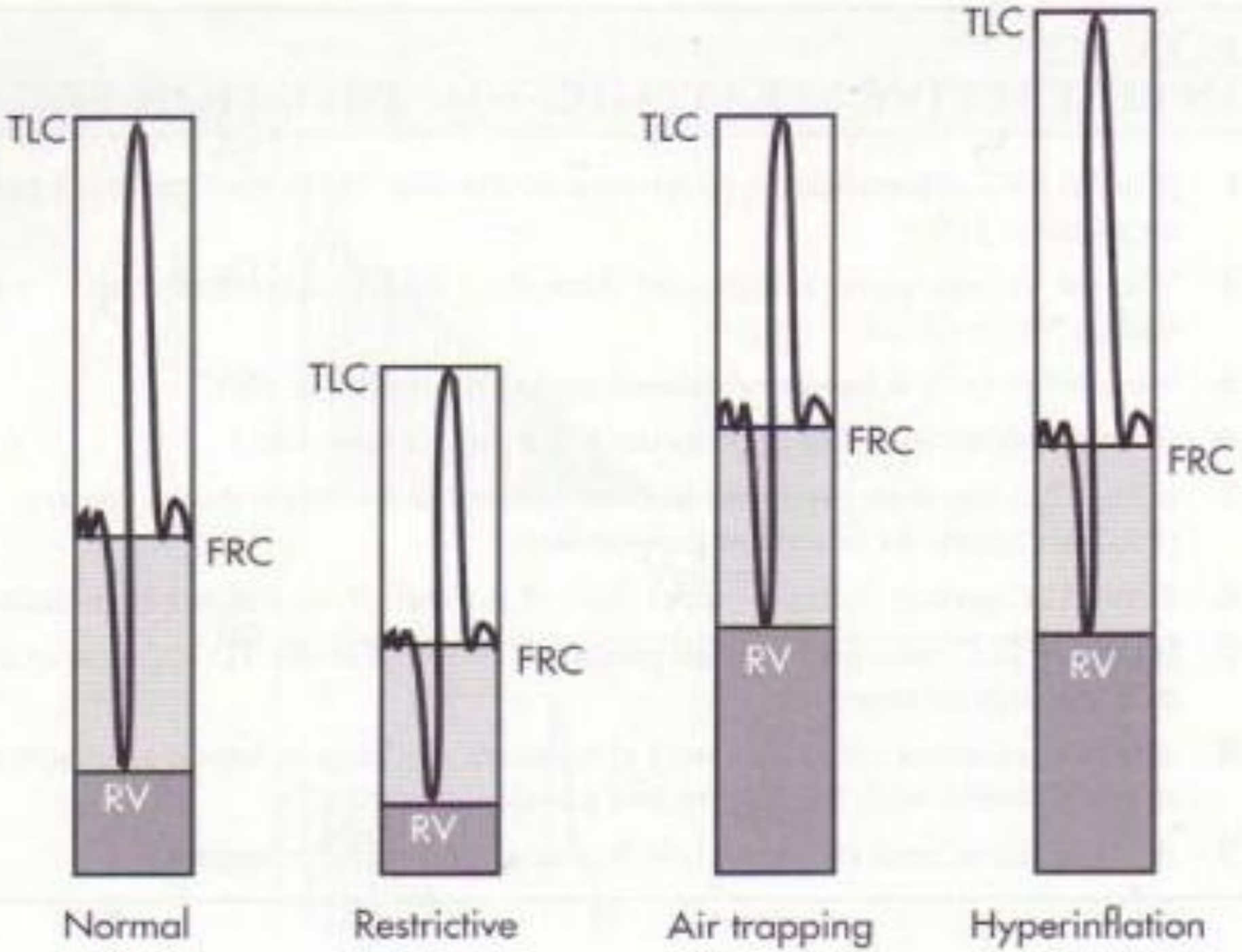
% Pred FEV1 < 80 and > 70 = Mild

% Pred FEV1 < 70 and > 60 = Moderate

% Pred FEV1 < 60 and > 50 = Moderately severe

% Pred FEV1 < 50 and > 35 Severe

% Pred FEV1 < 35 = Very severe


TLC
FRC
RV
Normal
TLC
FRC
RV
Restrictive
TLC
FRC
RV
Air trapping
TLC
FRC
RV
Hyperinflation