

PULMONARY FUNCTION TESTING EQUIPMENT

I. Spirometers

A. Water-sealed spirometers

1. components
 - a. bell suspended in water
 - b. a breathing system connects to the inside of the bell
 - c. changes in volume will alter the position of the bell up and down -
 - d. CO₂ can be removed -
 - e. kymograph -
2. tests performed on a water-sealed spirometer
 - a. lung volumes -
 - b. ventilation studies -
 - c. diffusing capacities -
 - d. pulmonary mechanics -
3. reliability of water-sealed spirometers
 - a. bell must be precisely counter weighted
 - b. resistance to movement (inertia) must be considered in calculating results -
 - c. corrections must be made for temp. and saturations of expired air
4. Collins water-seal
 - a. bell counterweighted by pulley
 - b. two recording pens
 - c. interchangeable bells
 - d. variable speed kymograph -
5. Stead-Wells water-seal -
 - a. bell is not counterweighted
 - b. inspiratory excursion deflects pen downward -
 - c. offers less resistance -

B. Dry rolling-seal spirometers

1. components
 - a. a piston with in a cylinder supported by a rod on friction-less bearings
 - b. piston is coupled to cylinder by a plastic seal -
 - c. cylinder is usually 10-12 liters
 - d. volume measurement is direct or through a potentiometer
2. tests performed on dry rolling-seal spirometer
 - a. lung volumes
 - b. ventilation studies
 - c. diffusion capacities
 - d. pulmonary mechanics
3. characteristics of dry rolling-seal spirometers
 - a. most use potentiometers activated by movement of the piston
 - b. no need for counterbalancing
 - c. most have electronic BTPS corrections, and preset calibration signals -
 - d. available with one-way circuits and CO₂ removers -
 - e. well adapted for interfacing with a computer

C. Bellows spirometers -

1. components
 - a. collapsible bellows
 - b. wedge bellows with pen attached
 - c. pen moves horizontally at a preset speed
2. tests performed on bellows spirometer -
 - a. VC and subdivisions

- b. timed VC's
- c. pulmonary mechanics
- 3. disadvantages of bellows spirometer
 - a. inaccuracy from inertia or resistance to movement of bellows

II. Pneumotachometers -

- A. Mechanical flow-sensing devices -
 - 1. uses rotating vane
 - a. measures volumes with flows between 3 and 300 L/min.
 - b. used to measure VC, VT, and V
 - 2. ideal for bedside use
- B. Pressure drop flow-sensing device -
 - 1. tube is designed to produce laminar airflow
 - 2. a resistive element causes press. to drop as air flows through it
 - 3. pressure drop is measured by a pressure transducer -
 - a. press. difference is proportional to flow -
 - b. electrical signal is integrated to derive volume
- C. Heat transfer flow-sensing devices -
 - 1. heated element is placed in the path of flowing gas -
 - a. as flow increases the wire cools more
 - b. the amount of current needed to keep the wire hot is proportional the magnitude of the flow
 - 2. signal is applied to an integrator -
- D. Vortex flow measuring devices -
 - 1. struts are placed in the axial airstream to create turbulence -
 - 2. an ultrasonic crystal downstream transmits high frequency sound waves -
 - 3. the number of pulses received is proportional to the frequency of the vortices
 - a. each tube is calibrated to length and strut size
 - b. system is insensitive to gas composition, temp., and humidity
 - c. accumulation of moisture can cause erroneous readings
- E. Uses, advantages and disadvantages of flow measuring devices
 - 1. uses
 - a. lung volume measurements
 - b. ventilation measurements -
 - c. distribution studies
 - d. pulmonary mechanics -
 - 2. advantages
 - a. precise testing with lightweight compact equipment
 - b. most do not use mechanical actions
 - c. most can be connected to X,Y recorders for hard copies
 - 3. disadvantages
 - a. are not accurate at extremes -
 - b. corrections can be made to "linearize" signals -
 - c. collectable water causes erroneous readings

III. Plethysmograph -

- A. Components
 - 1. pneumotachs
 - 2. pressure transducers -
 - 3. shutters (airflow) and airtight box
- B. Uses
 - 1. lung volume measurements -

2. compliance measurements -
3. airway resistance measurements -

IV. Recording and Output Devices

- A. kymograph -
 1. rotating drum with chart paper
 2. corrections for BTPS must be made
- B. Mechanical X-Y recorders
 1. constant speed motor moves pen along X axis (time)
 2. bellows or spirometer provides movement along Y axis (volume)
 3. mechanical resistance is a factor
- C. Electronic X-Y recorders
 1. receives electrical input (signal)
 2. signal drives small motor which in turn moves pen
 - a. many have a built-in time generator
 3. rates of pen movement can be varied
 4. must be calibrated