Health problem addressed

Spirometers aid in diagnosing lung diseases, classifying obstructive and restrictive disorders, and measuring the efficacy of subsequent therapies. They can help distinguish between pulmonary anomalies and anomalies of other origins. These units assist with baseline and trending of pulmonary function when a patient’s pulmonary function is changed because of cardiac and chemotherapy drugs. They are also used for preoperative evaluations and for screening workers at risk for pulmonary disease from occupational environmental exposures.

Product description

Diagnostic spirometers evaluate the mechanics of breathing using one of two methods: volume sensing or flow sensing. Volume-sensing devices collect exhaled air in a calibrated container and calculate airflow data from continuous volume information. Flow-sensing devices have a transducer placed directly in the airstream and calculate volume data from the airflow information.

Principles of operation

The water-seal spirometer is a counterweighted bell inverted into a water reservoir; the bell rises and falls as the patient breathes. Its motion moves either a transducer or a pen that records volume data on calibrated chart paper mounted on a rotating drum (kymograph). The low-friction water seal and counterweight limit resistance and back pressure so that the measurement itself does not adversely affect the patient’s response. In the second type, a dry rolling seal is used instead of water between the bell and its surrounding cylinder. Rolling-seal spirometers are often mounted horizontally to eliminate the need for a counterweight and to minimize the effect of gravity. The “waterless” or Stead-Wells dry-seal spirometer combines the water- and rolling-seal concepts. There are 4 types of transducers used – pneumotachometer, hot-wire anemometer, turbino-meter, and vortex shedding. The raw data collected during spirometric testing must be analyzed to determine commonly used ventilatory performance indexes. Waveform printouts large enough for hand calculation of spirometric values are useful in case the microprocessor malfunctions or the accuracy and stability of the spirometer must be verified.

Operating steps

- Tubing is attached to the spirometer. A mouthpiece or mask is attached to the tubing for the patient to breathe into.
- The patient performs specific breathing maneuvers from which the various volume and flow parameters are determined.
- The raw data obtained is analyzed to determine commonly used ventilatory performance indexes.
- Waveforms can be printed out for documentation reasons.

Reported problems

For water-sealed, volume-sensing devices, common problems include leaks, inaccurate measurement due to improper positioning, transportation difficulties, and extensive maintenance. For dry-sealed devices, problems include sticking of the rolling seal and increased mechanical resistance between the cylinder and piston. For bellows devices, problems include leaks and sticking of the bellows. The mouthpiece, tubing, and other air spaces can provide a warm, moist environment favorable to growth and transmission of disease-causing microorganisms.

Use and maintenance

User(s): Physicians, nurses, respiratory therapists, other medical staff, home care providers
Maintenance: Medical staff; technician; biomedical engineering staff and/or service contract with the manufacturer or third-party organization; central sterile processing technician for cleaning/disinfecting
Training: Initial training by manufacturer, operator’s manuals, user’s guide

Environment of use

Settings of use: Hospital, physician office, home
Requirements: Battery, line power

Product specifications

Approx. dimensions (mm): 130 x 90 x 30 for handheld units; 150 x 60 x 100 for PC-based units
Approx. weight (kg): 0.25 for handheld units; 3 for PC-based units
Consumables: Mouthpieces, tubing, paper, batteries
Price range (USD): 400-2,400 (1,200 typical) for handheld units; 1,500-4,100 (2,300 typical) for PC-based units
Typical product life time: 8 years
Shelf life (consumables): Variable

Types and variations

- Handheld units
- PC-based units