Interview with the Experts

What makes the MiniBox+ different from other PFT devices?

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We asked Dr. Jeffrey Fredberg of the Department of Environmental Health at the Harvard T.H. Chan School of Public Health, and Dr. Kenneth Berger of the Division of Pulmonary Critical Care and Sleep Medicine at New York University's Grossman School of Medicine, to explain how the MiniBox+ works and how it compares to whole body plethysmography.

Whole body plethysmography, or the body box, is considered the gold standard for lung volume measurements, yet it is not feasible and challenging for most pulmonologists and allergists. How do other methodologies compare to the body box for measuring lung volumes?

Professor Fredberg:
Five methods are recommended for measuring absolute lung volumes: whole body plethysmography, multi-breath helium dilution (He), nitrogen wash-out (N2), computerized tomography (CT), and chest radiography (CXR). Each of these techniques has pros and cons to the clinical user and the patient. CT and CXR are not utilized in pulmonary function laboratories and incur radiation exposure, while He and N2 may underestimate lung volumes as gas may not fully distribute to poorly ventilated areas. Body plethysmography may overestimate lung volume relative to other measurements primarily in the setting of airflow obstruction and increased compliance of the extrathoracic airway. Several comparative studies have demonstrated differences between the gas-based techniques (He and N2) and plethysmography with coefficients of variation ranging between 8.8% and 23.7%.

Whole body plethysmography is simple in principle but inherently complex in practice because patients must sit inside a sealed booth and perform a complex respiratory maneuver against a closed shutter (i.e. an occluded airway). While gas dilution and gas wash-out techniques are well-established alternatives to plethysmography they require more time to demonstrate repeatability between maneuvers, especially in patients with obstructive airway diseases. Moreover, these gas based techniques correlate well with plethysmography only in normal subjects; underestimates of lung volumes occur in patients with airflow obstruction.

Investigators have explored alternative avenues to determine absolute lung volumes by other means, but with no success. Respiratory system impedance, even when extended to a wide range of forcing frequencies, has been shown to be inadequate to infer absolute lung volumes in the individual subject. Similarly, forced expiratory maneuvers have been shown to be inadequate. These failures may be attributable in part to the fact that the dynamics of gas distribution within the human lung are complex, and especially so in obstructive lung disease. Moreover, data interpretation in these approaches often rests upon fitting data to idealized mathematical models wherein there exists a wide range of TGV values that might fit the data equally well. When this happens, no useful determination of TGV can be inferred.

How do lung volume measurements (or Total Lung Capacity, "TLC") with the MiniBox+ desktop device compare to whole body plethysmography?

Professor Fredberg:
Despite the simplicity of the measurement, TLC as measured by the MiniBox+ system is not significantly different from TLC measured by conventional whole body plethysmography. Moreover, the coefficient of variation for repeated measures is smaller. These observations validate the MiniBox+ method as a reliable method to measure absolute lung volumes.

The National Heart Lung and Blood Institute, the American Thoracic Society, and the European Thoracic Society have encouraged innovation in technologies to measure absolute lung volumes so as to attain improved accuracy, ease of use, and rapidity of testing, and have recommended rigorous testing to ensure no substantial differences in results compared with standard techniques. In all sub-populations tested to date, the MiniBox+ performed in a manner that compares favorably with body plethysmography. Also, the day-to-day variability of TLC measurement is smaller than that of TLCs derived from helium dilution, CT imaging, or body plethysmography. Accordingly, data published to date establish the validity of the MiniBox+ for rapid, accurate, and repeatable determination of TLC in a heterogeneous population of healthy adults and those with respiratory system diseases.

How does the MiniBox+ work?

Professor Fredberg:
The device sits on a desktop and comprises a flow-interruption valve connected to a rigid gas-filled container. TLC measurements are based on a series of short flow interruption events activated during the inhalation phase of the patient's normal breathing. These interruption events consist of rapid valve closures. Using these measurements together with data mining and machine-learning, the MiniBox measures for each interruption event the corresponding TLC, which is determined by the instantaneous lung volume during the interruption event plus the volume inhaled to TLC.

How does the MiniBox+ lung volumes testing process compare to traditional whole body plethysmography?

Professor Berger:
Whole body plethysmography can be quite challenging for patients with disabilities or claustrophobic tendencies, who may find it difficult to be confined inside a closed chamber for an extended time. In addition, testing involves a complex respiratory maneuver. For technicians, testing accuracy requires a high level of training and proficiency.

The MiniBox+ testing technique is actually quite easy for patients. Since there is no chamber, they can sit comfortably next to the device and perform normal tidal breathing in a relaxed manner.

A self-paced, e-learning MiniBox+ training program is provided by PulmOne free of charge. It is suitable for all medical office staff. In addition, fully automatic lung volumes and DLCO, as well as automatically generated results, minimize technician bias.

How does the MiniBox+ compare to the body box in terms of testing flow through times, particularly in light of the COVID PFT testing recommendations by ERS and ATS?

Professor Berger:
Lung volumes can be measured in roughly one minute, and complete PFT's in about 20 minutes.

With full mobility, the device can be easily moved into another clinic room during 15-minute air ventilation periods. The only downtime between patients is for a 5-minute disinfection wipe down.

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