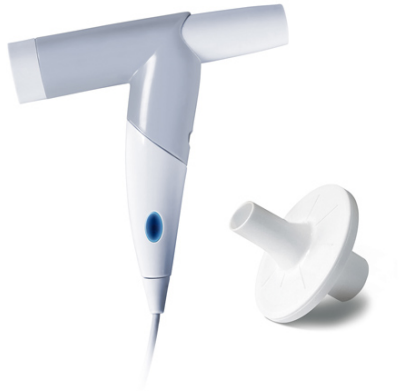
Spirometer

A **spirometer** is an apparatus for measuring the volume of air inspired and expired by the lungs. It is a precision differential pressure transducer for the measurements of respiration flow rates. The spirometer records the amount of air and the rate of air that is breathed in and out over a specified period of time.

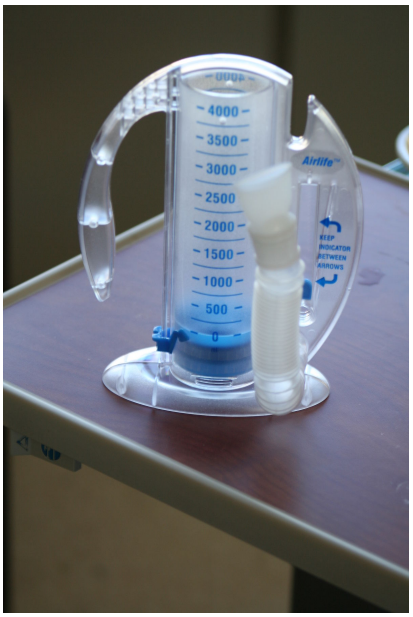
A Tank-type spirometer works on the same principle as the gasometer. A canister of soda is usually attached to absorb carbon dioxide and a kymograph trace is produced to record changes in total volume gas. From this, vital capacity, tidal volume, breathing rate and ventilation rate (=tidal volume x breathing rate) can be calculated. From the overall decline on the graph, the oxygen uptake can also be measured.



A modern USB PC-based spirometer.

Pulmonary function tests

Spirometer is one of the equipments used for basic Pulmonary Function Tests (PFTs). It is useful as a preliminary test of the health condition for patient's lung. Lung diseases such as asthma, bronchitis, and emphysema can be ruled out from the tests. In addition, it is often used for finding the cause for shortness of breath, assessing the effects of contaminants on lung functions, effect of medication, and progress for disease treatment.[1]



An incentive spirometer - used to help patients improve the functioning of their lungs

History

Early development

The earliest attempt for the measurements of lung volumes can be dated back to period 129-200 A.D. Claudius Galen, who was a Greek doctor and philosopher, first did a volumetric experiment on human ventilation. He had a boy breathe in and out of a bladder and found out that the volume did not change. Nothing much was learnt from this experiment.[2]

In 1681, Borelli tried to measure the volume of air inspired in one breath. He assembled a cylindrical tube partially filled with water, with an open water source entering the bottom of the cylinder. He occluded his nostrils, inhaled through an outlet at the top of the cylinder and measured the volume of air displaced by water. This technique is very important in getting parameters of lung volumes nowadays.[2]

Nineteenth century

In 1813, Kentish E used a simple "Pulmometer" to study the effect of diseases on pulmonary lung volume. He used an inverted graduated bell jar standing in water, with an outlet at the top of the bell jar controlled by a tap. The volume of air was measured in units of pints.[2]

In 1831, Thrackrah C.T described the "Pulmometer" similar to that of Kentish. He portrayed the device as a bell jar with an opening for the air to enter from below. There was no correction for pressure. Therefore, the spirometer not only measured the respiratory volume, but also the strength of the respiratory muscles.[2]

In 1845, Vierordt in his book named "Physiologie des Athmens mit besonderer Rücksicht auf die Auscheidung der Kohlensäure" in which his main interest was to measure the volume of expiration accurately. However, he also completed accurate measures of other volume parameters by using his "Expirator". Some of the parameters described by him are used today which included residual volume and vital capacity.[2]

The water spirometer measuring vital capacity was developed by a surgeon named John Hutchinson, in 1846. He invented a caliberated bell, inverted in water, which was used to capture the volume of air exhaled by a person. John published his paper about his water spirometer and the measurements he had taken from over 4,000 subjects,[2] describing the direct relationship between vital capacity and height and inverse relationship between vital capacity with age. He also showed that vital capacity does not relate to weight at any given height. He also used his machine for the prediction of premature mortality. He coined the term vital capacity, which was claimed as a powerful prognosis for heart disease by Framingham study. He believed that his machine should be used as an acturial predictions for companies selling life insurances.[3]

In 1854, Wintrich developed a spirometer, which was easier to use than Hutchinson's. He did an experiment with 4,000 experimental subjects, and concluded that there are 3 parameters affecting vital capacity: body heights, weights and age, which showed similar results as Hutchinson's study. In 1879, Gad J. published a paper named "Pneumatograph" which allowed the recording of lung volume changes.[2]

Twentieth century

In 1902, Brodie T.G was the first using a dry-bellowed wedge spirometer. Wright B.M. and McKerrow C.B. introduced the peak flow meter in 1959. In 1969, DuBois A.B. and van de Woestijne K.P. experimented on humans the whole body plethysmograph. In 1974, Campbell et al. refined the previous peak flow meter and put forward a cheaper and lighter version of a peak flow meter.[2]

Types of spirometer

Whole body plethysmograph

This type of spirometer gives a more accurate measurement for the components of lung volumes as compared to other conventional spirometers. A person is enclosed in a small space when the measurement is taken.

Pneumotachometer

This spirometer measures the flow rate of gases by detecting pressure differences across the fine mesh. One advantage of this spirometer is that the subject under investigation can breathe in fresh air during the experiment.[4]

Fully electronic spirometer

Electronic spirometers have been developed that compute airflow rates in an channel without the need for fine meshes or moving parts. They operate by measuring the speed of the airflow with techniques such as ultrasonic transducers [5], or by measuring pressure difference in the channel such as the DynamicMT spirometer [6]. These spirometers have greater accuracy by eliminating the momentum and resistance errors associated with moving parts

such as windmills or flow valves for flow measurement. They also allow improved hygiene between patients by allowing fully disposable air flow channels.

Incentive spirometer

This spirometer is specially designed to improve one's functioning of the lungs.

Peak flow meter

This device is useful for measuring the ability of a person breathing out air.

Windmill-type spirometer

Windmill-type spirometer is also known as **Spiropet spirometer**. It is used specially for measuring forced vital capacity without using water and has broad measurements ranging from 1000 ml to 7000 ml. It is more portable and lighter as compared to traditional water-tank type spirometer. This spirometer should be held horizontally while taking measurements because of the presence of rotating disc.[7] [8]

References

[1] *Pulmonary function tests* (http://www.nlm.nih.gov/medlineplus/ency/article/003853.htm) URL assessed on 27 December 2009

[2] *Spirometer history* (http://medizin.li/spirometer/spirometer-history.html) URL assessed on 21 November 2009

[3] *John Hutchinson's Mysterious Machine Revisited* (http://chestjournal.chestpubs.org/content/121/5_suppl/219S.full.pdf+html) URL assessed on 21 November 2009

[4] *PNEUMOTACHOMETER/GRAPH* (http://home.btconnect.com/MalcolmBrown/entries/PNEUMOTACHOMETER_GRAPH.html) URL assessed on 26 December 2009

[5] http://www.nddmed.com/index/ultra-flow

[6] http://www.dynamicmt.com/Patents.html

[7] *Spiropet spirometer* (http://www.fact-canada.com/SpiroTiger/Spiropet-Spirometer.html) URL assessed on 21 November 2009

[8] *AME Spirometer* (http://www.advancedmedicalengineering.com/spirometer.html) URL assessed on 21 November 2009

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