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PNEUMOMETRY

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The most important factor causing dyspnea in asthma is bronchial obstruction. It hinders the airflow in the bronchial tree. Thus the best method to investigate bronchial obstruction would be the measurement of bronchial resistance to air flow. For this, according to Poiseuille's law, alveolar pressure and flow rate in the bronchi have to be known.

$$\text{Bronchial resistance} = \frac{\text{alveolar pressure}}{\text{flow rate}}$$

Several methods to determine bronchial resistance are in use, but all of them are technically rather complicated because the evaluation of alveolar pressure is cumbersome. We have used for many years a modification of Vuilleumier's "interruption method" which recently has been improved by Jaeger.

But considering the air flow rate alone can already give some evidence of ventilatory disturbances, e.g. by measuring the maximum forced expiratory flow rate. In any given individual we can expect maximal expiratory pressure approximately equal to alveolar pressure, to be constant. A diminished peak flow rate is generally the result of a high bronchial resistance. On the other hand it can also be due to weakness of expiratory muscles as well as to a nonelastic thorax.

Our pneumometer (*Wyss & Hadorn*), the conception of which has been given by *Hadorn* in 1942, consists of a tube with a diameter of 30 mm and a diaphragm with an opening of 15 mm through which the patient blows. The fall in pressure due to this diaphragm varies as the square of the flow

rate. Since the peak flow rate is reached within a very short period of time, a sensitive manometer with little inertia is necessary. We used a manometer with a very thin metal membrane and an optic lever to read or register the pressures.

The instrument permits to record rates from 0,2 to 11,0 l/sec.

Age, sex and body height determine the standard values. The normal values of vital capacity too depend on these same factors. Therefore the easiest way to determine the standards is to calculate the normal value of the vital capacity for the patient an afterwards to read the peak flow rate on a nomogram (*Zehnder*).

Our standard values correspond quite well to those obtained with different other peak flow meters (*Wright*). The procedure is utmost simple and can be performed on the bedside or any other situation in a very short time. Bad cooperation of the patient or weakness of the expiratory muscles lead to false results. In asthma and emphysema peak flow rates are diminished without exception. In latent asthmatic conditions, when pneumometer values may still be normal, the inhalation of a bronchospasmolytic aerosol augments the peak flow rate. With this the detection of slightest bronchial obstruction is possible.

The measuring of the peak flow rate has about the same significance as Tiffeneau's timed vital capacity. The figure on the left side shows a spirometer tracing during forced expiration. Timed vital capacity corresponds to the volume of air leaving the lungs within the first second of a forced expiration. The peak expiratory flow rate would be the tangent drawn to the steepest part of the curve. The picture on the right shows the flow rate during a forced expiration. The top of the curve corresponds to the peak flow rate in l/sec. The area enclosed by the curve in the first second of expiration corresponds to the timed vital capacity.

Comparing those two pictures, we can see what size is determined by each of the two methods. Generally the results obtained with these two methods are corresponding. Under

certain circumstances differences can be observed which may be of diagnostic value. The two following examples may show this. In poliomyelitic palsy the expiratory force is abolished and therefore expiratory flow rate is very low, whereas the timed vital capacity may be normal, since it is expressed as percentage of the effective vital capacity. On the other hand a normal expiratory flow rate together with a lowered timed vital capacity has been found by *Scherrer* in a patient suffering from stenosis of the left main bronchus. During forced expiration the air escaping from the healthy right lung produced a normal peak air flow rate, whereas the total air volume leaving the lungs in the first second was clearly diminished. After resection of the bronchial stenosis, timed vital capacity returned to normal, whereas the previously normal peak flow rate remained unchanged. These mentioned conditions surely are exceptions.

After a period of 20 years of experience, we think that pneumometry is a very valuable and simple method to evaluate bronchial obstruction in asthma, emphysema and several forms of bronchitis.

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