Relationship Between Peak Flow Rate (PFR) and Other Tests of Ventilatory Capacity*

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INTRODUCTION

MEASUREMENTS OF EXPIRATORY FLOW rate have been used for a number of years in evaluation of obstructive ventilatory defects. Patient's ability to blow out a candle or a lighted match held at a fixed distance from the mouth have been utilized in assessing ventilatory capacity. Hadorn in 1942 introduced the measurement of peak flow rate in assessing obstructive defects and since then, air flow has been determined by means of pneumotachograph and "puffmeter" among other devices. Other workers have measured the same aspect of pulmonary function using a spirometer and determining the forced expired volume per unit time, usually the first second (FEV1.0), and expressing it as per cent of the total expired volume.

The Wright peak flow meter, a device for measuring expired air flow rate, was introduced in 1959 for assessing ventilatory capacity, particularly in obstructive ventilatory disease, and it has been used widely since because of its ease management, accuracy and reproducibility. A number of studies have already shown the usefulness of this method of peak flow rate (PFR) measurement for rapid determination of pulmonary reserve, for preoperative assessment of pulmonary function or in evaluating changes in patient's degree of pulmonary disability.

Although the value of peak flow measurement seems fairly well-established, there have not been many studies on the relationship of peak flow with other simple and fairly well-established tests of ventilatory capacity. The present study was undertaken to determine the relationship between peak flow rate and maximum breathing capacity (MBC), first second vital capacity (FEV1.0) and total vital capacity (VC).

MATERIALS AND METHODS

This study is based on findings in 461 patients, 325 men and 136 women, referred to the Pulmonary Laboratory of the Massachusetts General Hospital between July 1, 1963 and June 30, 1964. The average age of the group was 55.9 years with a range of 7 to 88 years. Most of the patients studied had some form of pulmonary and/or cardiac disease, although a certain number of them had no primary cardiopulmonary disorder. These patients were referred to the laboratory for evaluation of pulmonary function. Each subject's height and weight was determined and the following tests were carried out:

1. Peak Flow Rate: In a sitting position, the subject held the peak flow meter in his hands and blew into it through a cardboard mouthpiece rapidly after a full inspiration. A minimum of three measurements were made in each subject and the highest value obtained recorded. The results were then expressed as per cent of the predicted values based on the figures of Nairn et al. in children and those suggested by the manufacturers in adults.

2. FEV1.0 and Total Vital Capacity: These measurements were made from a sitting position using the 6 liter Collins vitalometer. A minimum of three measurements were made in each patient and the highest value recorded used in this study. FEV1.0 was then expressed as per cent of the measured total vital capacity and the vital capacity as per cent of the predicted normal value. The predicted normal values
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of Baldwin et al.11 were used for the total vital capacity.

3. Maximum Breathing Capacity. The MBC was measured by having the patient breathe as hard and fast as possible for 15 seconds through a modified Otis-McKerrow valve into a meterologic balloon. The volume of air collected was then measured in a Tissot spirometer, multiplied by four to obtain the volume for one minute and corrected to body temperature and pressure saturated with water vapor (BTPS). The result was then expressed as per cent of the predicted normal value based on the tables of Baldwin et al.11 A minimum of three measurements were made in any individual whose measured MBC deviated from the predicted value by more than ±20 per cent and the highest recorded value used in this study.

RESULTS

All the values in this study are presented as per cent of the predicted normals, as opposed to absolute values, since in this manner the naturally occurring differences due to age, sex, height and weight would not have to enter into consideration.

Peak Flow Rate and MBC. The relationship between PFR and MBC is shown in Fig. 1; both values are expressed as per cent of the predicted normal values. There appears to be a high degree of correlation between PFR and MBC and the correlation coefficient (r) between the two is 0.80.

Peak Flow Rate and FEV₁0. The relationship between PFR and FEV₁0 is shown in Fig. 2. PFR is expressed as per cent of predicted normal value. FEV₁0 values as expressed in this figure require some explanation. A correction factor of 100/80 was applied to all the FEV₁0 values so that a normal first second vital capacity of 80 per cent of the total vital capacity is expressed as 100 per cent in Fig. 2. Introduction of this correction factor allows FEV₁0 to be presented in the same man-

![Figure 1: Relationship between peak flow rate and maximum breathing capacity in 461 patients. The solid diagonal line represents the ideal regression line and the two dotted lines represent the boundaries for ±20 per cent variation from the ideal.](http://journal.publications.chestnet.org/pdfaccess.ashx?url=/data/journals/chest/21441/)
ner as PFR, namely, a normal value for each measurement would then be 100 per cent. This correction factor was based on the fact that in normal subjects it has been shown that \(FEV_{1.0}\) is about 80 per cent of the total vital capacity.\(^5\)

There appears to be a good correlation between PFR and \(FEV_{1.0}\), when both values are above 70 per cent, but less so with values below 70 per cent. The correlation coefficient \((r)\) for the entire series was calculated to be 0.61.

**Peak Flow Rate and Total Vital Capacity.** The correlation between PFR and VC was the poorest of those measured and the correlation coefficient \((r)\) was calculated to be 0.57.

**DISCUSSION**

Results of this study indicate a close correlation between peak flow and MBC, the correlation coefficient being 0.80. This suggests that the PFR has essentially the same significance as the MBC in assessing ventilatory capacity or detecting obstructive airway disease. Figure 2 indicates that in obstructive airway disease PFR measurements are more sensitive in detecting abnormalities than \(FEV_{1.0}\), since practically all PFR values less than 70 per cent are above the ideal regression line. Restrictive ventilatory defects as measured by the total vital capacity are reflected to a lesser degree in peak flow measurements as evidenced by a correlation coefficient of 0.57 between PFR and VC.

Other studies have also demonstrated high degrees of correlation between peak flow and timed vital capacity. Lockhart et al.\(^9\) calculated a correlation coefficient between PFR and \(FEV_{0.75}\) of 0.81 for men and 0.62 for women. Ritchie\(^\alpha\) showed a correlation coefficient of 0.82 between PFR and \(FEV_{1.0}\), and Rosenblatt et al.\(^\beta\) demonstrated a correlation coefficient of 0.85 between the same variables. The correlation between MBC and peak flow of 0.80 in the present study is higher than that of 0.66 reported by Rosenblatt et al.\(^\gamma\)

**FIGURE 2:** Relationship between peak flow rate and first second vital capacity in 461 patients. The solid diagonal line represents the ideal regression line. For explanation of \(x\) 100 values see Results.\(\frac{FEV_{1.0}}{VC}\)
Peak flow rate measurements are useful in detecting obstructive ventilatory disease. They are easy to perform and require little effort on the part of the patient. In addition, the peak flow meter is small and portable. This method of testing is particularly valuable in following the ventilatory capacity of seriously ill patients or those recovering from major surgery; and because of ease of management should lend itself well to conducting surveys to detect obstructive ventilatory disease. In view of the close correlation between PFR and MBC, peak flow determinations should also be of value in patients in whom the MBC cannot be measured easily because of the patient’s illness or lack of sustained cooperation.

SUMMARY

The relationships between peak flow rate and MBC, FEV₁₀ and VC were studied in 461 patients. The correlation coefficient \( r \) was found to be 0.80 between PFR and MBC, 0.61 between PFR and FEV₁₀, and 0.57 between PFR and VC.

Measurement of peak flow rate in detecting ventilatory disease or in following a patient’s ventilatory capacity is recommended.

RESUMEN

Las relaciones entre el flujo respiratorio máximo, capacidad respiratoria máxima, el volumen expiratorio forzado \( FEF_{10} \) y la capacidad vital fueron determinadas en 461 pacientes. El coeficiente de correlación \( r \) resultó ser 0.80 entre FRM y CRM, 0.61 entre FRM y VEF₁₀, y 0.50 entre FRM y C.V.

El autor recomienda como útil la determinación del FRM en el diagnóstico de las enfermedades que afectan la ventilación pulmonar y en investigación de la capacidad ventilatoria.

ZUSAMMENFASSUNG

Die Beziehungen zwischen PFR und MBC, FEV₁₀ und VC wurden bei 461 Patienten untersucht. Es wurde festgestellt, dass der Korrelations-Koeffizient \( r \) 0.80 zwischen PFR und MBC, 0.61 zwischen PFR und FEV₁₀ und 0.57 zwischen PFR und VC war.

Die Messung von PFR zur Ermittlung von Ventilationsstörungen oder zum Verfolgen der Ventilationskapazität eines Pat. wird empfohlen.

REFERENCES