Peak Expiratory Flow Rate (PEFR)-A simple ventilatory lung function test.

(A review article)

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Introduction

Peak expiratory flow rate is the maximal expiratory flow rate sustained by a subject for at least 10 milliseconds expressed in Litre per minute (L/min)[1,2]. PEFR had been used as measurement of ventilatory capacity for long since mainly because of a much simpler and less tiring procedure than maximum voluntary ventilation (MVV). PEFR can be measured by a simplified device, min-Wright peak flow meter, which is cheap, easily portable, available and clinically reproducible[3].

Physiological consideration and historical background

The basis of most of the various single-breath methods is the same: the volume of air expired is measured against time by means of a spirometer with either a recording drum or a timing device. The empirical use of a measurement of ventilatory function is very old. "The physician asked a patient with respiratory disease to whistle or blow a candle out was crudely assessing the maximum respiratory velocities". Donald in 1953 suggested that a "simple, whistle-like instrument" might be developed and might become a standard clinical tool.

Later on the instrument, called a "pneumometer" incorporates an aneroid manometer fitted with a device for recording the maximum flow rate. Rates up to about 700 L/min. can be recorded. Pneumotachograph themselves have had very low resistances (of the order of 2 mm. H_2O/100 L/min) which gave a linear relationship between flow and pressure. Both the earlier and the latest forms of pneumotachograph suffer from the disadvantage of being fairly complicated and not easily portable. A much simpler and portable instrument, designed specifically for measuring the peak flow rate, called the "puff meter". Wright and McKerrow described the peak flow meter[5]. Since that time the instrument has been used widely and has been found reliable over long periods. The Wright peak flow meter depends upon the rotation of a vane attached to a spiral spring. Movement of the vane uncovers an annular orifice and the point at which pressure behind the vane balances the force of the

spring depends upon the flow rate. The standard Wright's peak flow meter ranges from 50-1000 L/min and weight 900 gm[5]. Later on various portable smaller and cheaper instruments suitable for domiciliary practice have been developed.

The peak flow gauge (Ferraris Development and Engineering Co. Ltd, London N18 3JD, UK) correlates closely with the PFM[4] but is too bulky to be carried easily. The pulmonary monitor[5] is pocket-sized, reliable and gives reproducible values that correlate well with the PFM. Unfortunately the monitor has a scale differing from the standard PFM. This would make comparison between trials difficult. Lastly a mini-Wright peak flow meter (Fig-1) has become available[6] (Airmed, Clement Clarke International Ltd, Airmed House, Edinburgh Way, Harlow, Essex CM20 2ED UK).

mini-Wright Peak Flow Meter (mWPFM)

This instrument is simpler version of the Wright peak flow meter now used worldwide. The instrument is a light plastic Cylinder measuring 15x5cm weighing 72 gm (without mouth piece). It consists of a spring piston that slides freely on a rod within the body of the instrument (Figure 1). The piston drives an independent sliding indicator along a slot marked with a scale graduated, low range from 50-350 L/min and high range from 60-800 L/min. The indicator records the maximum movement of the piston, remaining in that position until return to zero by the operator. In use the machine must be held horizontally with air vents uncovered. The instrument may be cleaned easily in running water or in a detergent solution. Details of washing and sterilization methods are supplied in leaflet along with the meter. Studies involving long-term use of this device, particularly the mini-Wright peak flow meter, has demonstrated that performed well for many months and with as may as 4000 blows[7]. Performance of accuracy of the mini-Wright peak flow meter meets national asthma education programme (NAEP) guideline variation <± 5% with standard Wright peak flow meter[8].

Factors affecting the peak expiratory flow rate (PEFR)

Anthropometric measurements: Standing height is the best single predictor in childhood for PEFR. It has more or less linear relationship with weight, body surface area and chest expansibility[9].

Age and Sex: Age has linear relationship with PEFR but sex has no significant relation with PEFR in children when height is considered[10]. But age has curvilinear in male and linear relationship in female of adult and when only age is considered, PEFR differs in both

sexes[11].

Malnutrition: Current malnutrition impairs the PEFR and chronic malnutrition is associated with reduction in PEFR/Age, perhaps because of slow growth of the large airways[12].

Environmental effect: Smoking and environmental tobacco smoke increases airway variability, thereby affect pulmonary function test as a PEFR[13]. Summertime particulate air pollution has independent effect on PEFR and is associated with decline in PEFR in children[14,15].

Respiratory tracts and thoracic cage: The PEFR occurs early in the expiration and is dependent on personal effort, large airway resistance and possible compressive effect of the maneuver on the intrathoracic airway[16,17].

How to use mini-Wright peak flow meter

The purpose and technique of the test should be explained to the subject followed by a demonstration of its performance. Person should perform the test in standing position holding the peak flow meter horizontally without interfering with the movement of the marker (arrow) or covering the slot. He or she should asked to take deep breath then exhale it by forceful expiration as fast as possible after maintaining air tight seal between lip and mouth piece of the instrument. Reading should be taken keeping the instrument horizontal position. Besides this, distributor of mini-Wright peak flow meter supply leaflet, which contains detail procedure with demonstration. The process of daily recording of PEFR has depicted clearly[19].

Clinical interpretation of values of PEFR

Personal based value of PEFR can be compared to normal reference population and also with predicted value from regression equation[20]. School-based study at Dhaka has produced the prediction equation for calculation of PEFR values of Bangladeshi boys, PEFR=5.96XHeight-495 and for girls, PEFR=5.70XHeight-479. Besides this formula, PEFR values of Bangladeshi boys and girls can be ready find out by using nomogram (Fig-2 and Fig-3). Similar type of nomogram had been used to find out PEFR of different country[21,22,23].

Diurnal variation in PEFR is a good indicator of circadian bronchial labiality responsiveness. PEFR record with diurnal variation of 20% or more is a good clinical and occupational indicator of asthma[24].

PEFR variability- diurnal variation in peak flow rate expressed as the formula as follows[26].

$$Daily\ variability\ = \frac{HighestPEFR - LowestPEFR}{HighestPEFR} \times 100$$

Bronchial provocation test by exercise in 'exercise induced asthma' is diagnostic when PEFR falls 15% of personal based after exercise and reversibility of airway obstruction is evidenced by an increased in PEFR more than 20% after an adequate dose of nebulized bronchodilator is diagnostic for asthma. Peak expiratory flow rate morning-to-evening variation ≥20% is consistent with asthma [27].

Self-management of bronchial asthma is advised to maintain a peak flow chart and personal based result should be interpreted in following ways-

Green zone (Safe zone) - 80-100% of personal best result

Yellow zone (Zone of alert)- <80%->50% of personal best result

Red zone (Zone of emergency)- <50% of personal best result[28]

PEFR can be used as treatment scheme of asthma. The important element of this scheme is as follows: If the PEFR is ≥70% of personal best, then maintenance regimen of twice daily inhaled bronchodilator and inhaled corticosteroid is continued. A value <70% of personal best result requires a period of doubling of the inhaled corticosteroid dose. At <50% of personal best result, a course of oral steroid is triggered, and the patient makes telephone contact with the physician[3].

Peak flow monitoring specially valuable for detecting deterioration of asthma, for predicting acute exacerbation of asthma and its management. Availability of peak flow measurement not only allows formulation of a management plan with criteria for both intensification of therapy and recourse to medical assistance. Regular measurement of peak flow allows objective determination of effect of therapy[29,30]. Peak flow measurement can be used to titrate maintenance treatment and deserve wider use in monitoring the adequacy of treatment of asthma[31].

PEFR is highly sensitive and accurate index of airway obstruction. It can be used as a guideline of admission and discharge of asthma when: *PEFR value >60% of expected*- admission is probably unnecessary, *40-60% of expected*- consider admission and <40% of expected- admission is probably necessary[32].

Peak flow measurement is sensitive indicator to measure the strength of muscles of respiration[44]. So, serial measurement of PEFR in Guillain-Barre syndrome or progressive

flaccid paralysis to predict the involvement of respiratory muscle is clinically important to give warning of the hypoventilation and need for ventilator support [33].

Conclusion

Use of peak expiratory flow rate as a measurement of ventilatory function test is an ancient. This simple ventilatory lung function test, measured by mini-Wright peak flow meter, is very useful in diagnosis, management and follow up of reversible air way diseases mainly bronchial asthma.

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Fig- 1: mini-Wright Peak flow meter

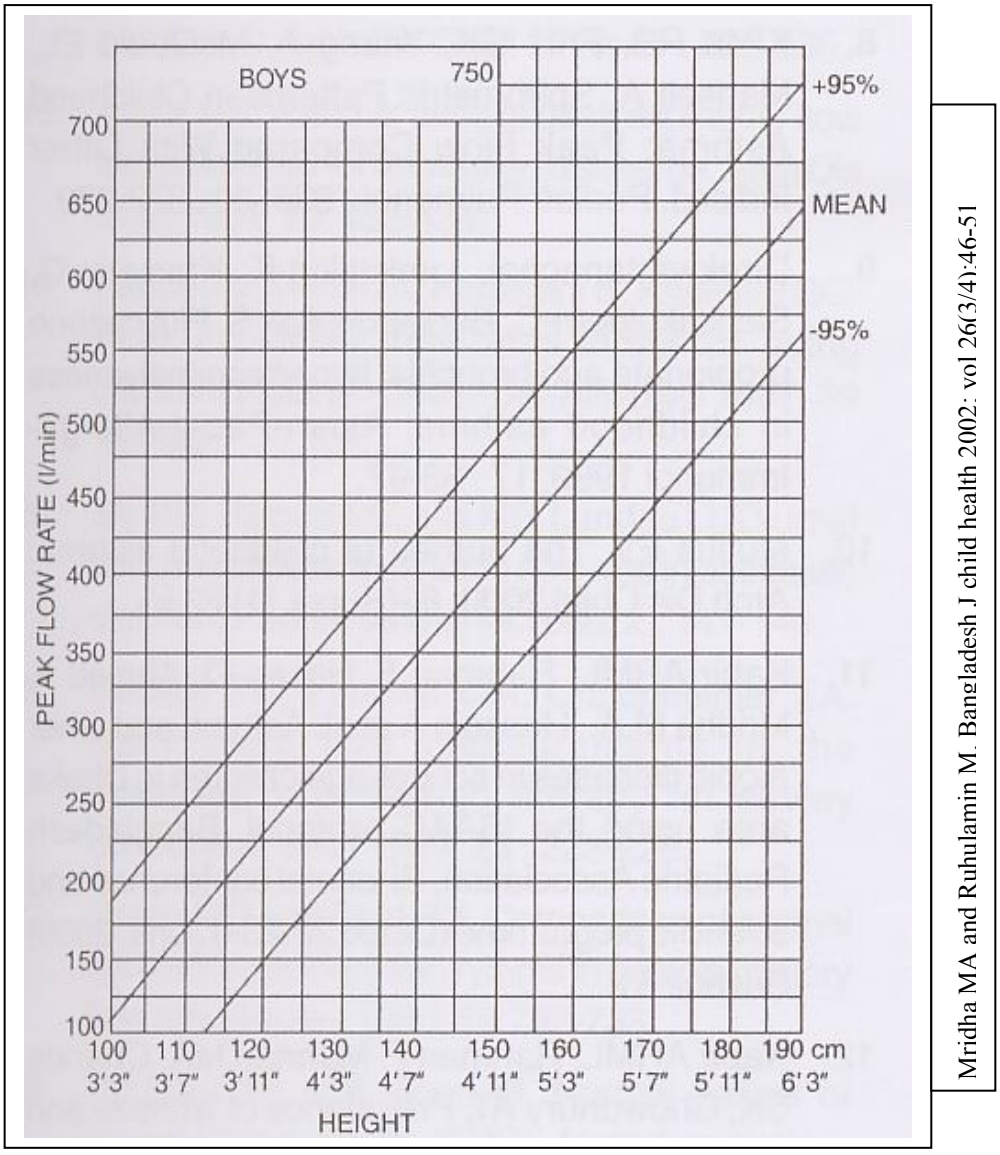

Fig-2: Nomogram of normal school children in relation to height (Bangladeshi boys)

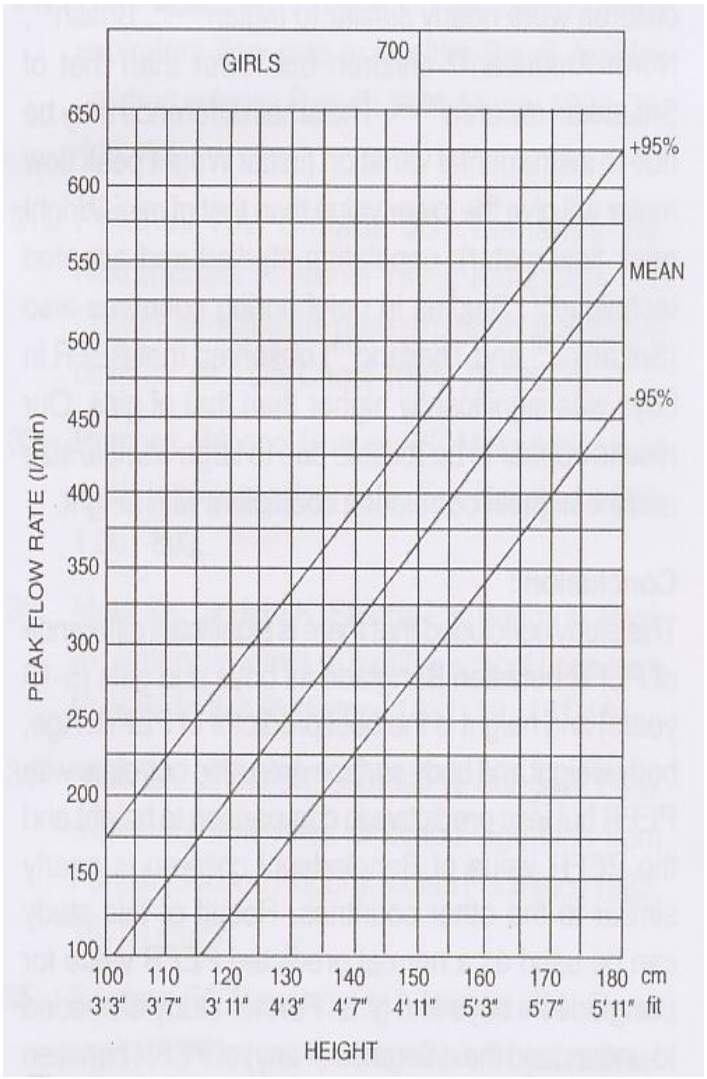

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Fig-2: Nomogram of normal school children in relation to height (Bangladeshi girls)