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RESEARCH ARTICLE

PEAK EXPIRATORY FLOW RATE (PEFR): CONCLUSION AND RECOMMENDATION

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ABSTRACT

Pulmonary function tests are useful in evaluation of respiratory health of a person. Peak flow meter is the one of the simplest means of objectively assessing and monitoring the airway function. The normal peak expiratory flow rate (PEFR) is 400-600 L/min or 6-10 L/sec. PEFR increase in male till third decade and in females till second decade, and later decline with as age increases. Peak flow meter helps to regularly monitor and in self management of asthma.

INTRODUCTION

Peak expiratory flow rate is the maximum velocity in liters per minute with which air is forced out of the lungs in a single forced expiratory effort from a position of maximal inspiration. It is one of the simpler and less tiring procedure for measurement of ventilator capacity. The normal value of PEFR is 400- 600 L/min or 6-10 L/sec. Various types of peak flow meters, including pneumotachometers, spirometers, turbines and anemometers are available. Commonly used instruments in clinical practice are flow meters referred to as peak flow meters. It is a small hand-held device that works on principle of a variable orifice to measure airflow indirectly. The pressure exerted by a forced expiration causes diaphragm to move and open a progressively larger area of the orifice. When there is no movement of diaphragm it is the point of maximum pressure which is generated as peak expiratory flow. (Quanjer *et al.*, 1997)

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. All the methods, however suffer from disadvantage. According to Donald (1953) 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 a crudely assessing the maximum respiratory velocities." He suggested that a simple, whistle – like instrument might be developed and might become a standard clinical tool. (Wright 1959; Hardon (1942) measured peak flow rate on expiration by arenoid manometer connected across a simple orifice but its resistence was high, only recording by maximum deflection by judging it by eye. 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. Silverman, Whittenberger, Lilly (1950), has used improved forms of Pneumatochograph themselves had very low resistance but were complicated and not easily portable. A much simpler and portable instrument, called ' puff meter' for measuring the peak flow rate were designed. Wright BM and McKerrow described the peak flow meter (Wright 1978). The standard Wrights peak flow meter ranges from 50 – 1000 L/min and weight 900gm. Subsequently more portable, lower-cost version (Mini- Wright peak flow meter) other designs and copies have being available. (Airmed, Clement Clarke International Ltd).Now brands of electronic peak flow meters are also available.

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Peak Flow Meter

There are several brands of peak flow meters all perform the same function. Mini- Wright peak flow meter is a short light plastic cylinder measuring 15x5cm weighing 72gm (without mouth piece). It consists of a spring piston that slides freely on a rod within the body of the instrument. The piston has an indicator along a slot marked with a scale graduated in liters/min. The indicator records the maximum movement of the piston, and remains in the position until return to zero by

the operator. The end, opposite to the mouthpiece, has holes in it for allowing air to exit from the apparatus. Washing and sterilization methods are supplied in leaflet along with the meter. Mini-Wright peak flow meters are reliable even after 5years of use. In long term studies, renewal of peak expiratory flow meters should be restricted to cases of obvious malfunction. (Douma *et al.*, 1997)

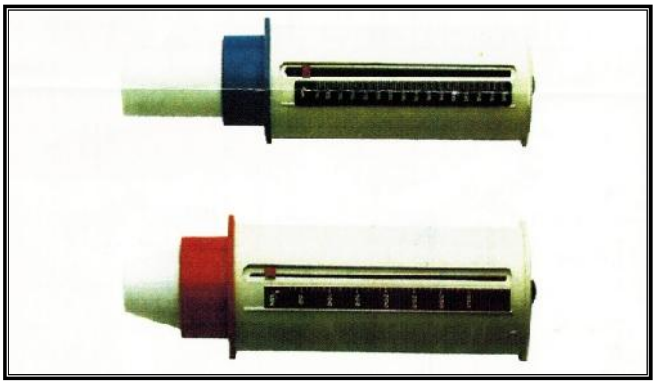

Figure 1. A peak flow meter

There are two types of peak flow meters: the low range from 50-350 L/min for children of age 4 to 9 years and adults with severely impaired lung function; and the high range from 60-800L/min for older children, teenagers, and adults. As adults have larger airways than children. If they use low range peak flow meter, they will have maximum peak flow rates, even with shortness of breath and false values affect the proper management. (Adeniyi and Erhabor 2011) Accuracy of the mini-Wright peak flow meter meets national asthma education programme (NAEP) guideline variation <±5% with standard Wright peak flow meter. (Wright 1978)

How to use the peak flow meter

Figure 2. Use of peak flow meter

The importance of use and proper technique should be explained to patient, along with the practical demonstration of its performance. The test has to be performed in standing position holding the peak flow meter horizontally by its handle making sure that the fingers are clear of the scale and the slot, and are not obstructing the holes at the end of the apparatus. Cursor is set to zero mark. Ask the subject to take a deep breath, place the mouthpiece firmly between the teeth and lips maintaining air tight seal, and then to blow out with a short sharp blast. Note the reading on the scale. Return cursor to zero and repeat this sequence twice more, take three readings at intervals of 1 minute, and select the maximum value for record. The highest of all three reading is noted in peak flow chart.

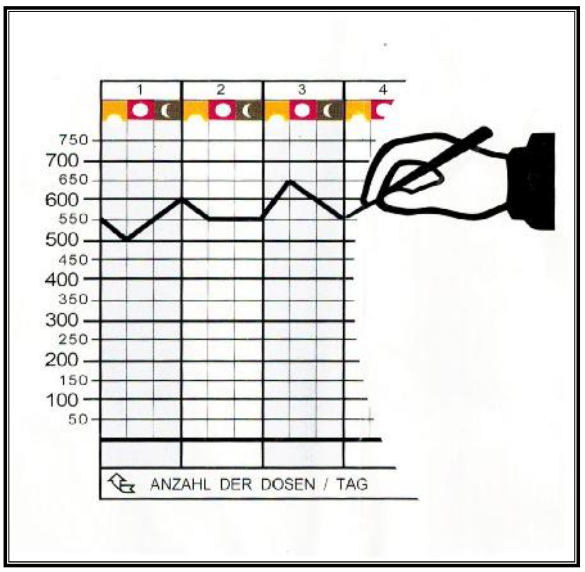

Figure 3 shows peak flow chart, which has dates with different time of day, with peak flow scale on left margin starting from 50L/min to 750L/min

Normal peak flow rate

It varies according to age, height, and sex. Personal based value of peak expiratory flow rate (PEFR) can be compared to normal reference population and also with predicted value from regression equation. (Pfaff and Morgan 1994) School-based study at Dhaka has produced the prediction equation for calculation of PEFR values. (Al- Amin Mridha *et al.*, 2002) For boys= 5.96 X height – 495 and for girls PEFR = 5.70 X height -479 Patient's normal score should be within 20% of a person of same age, sex and height who does not have asthma.

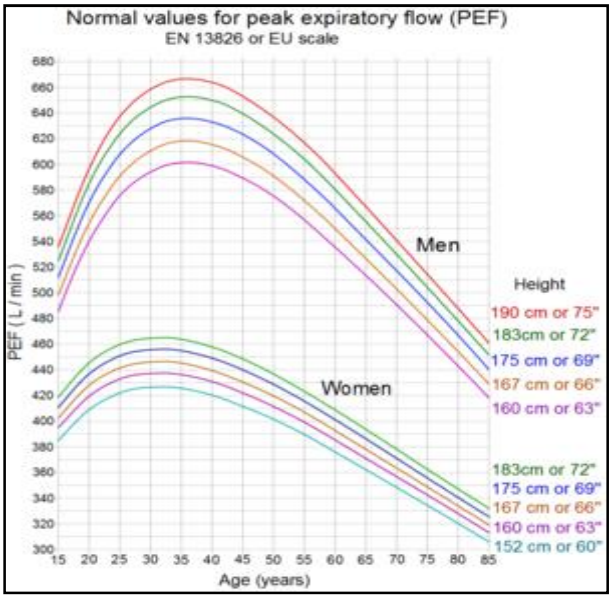

Figure 4. shows EU scale an example of a nomogram which can assist in estimating the best peak flow reading of the subject

Physiological determinants of peak flow meter

1. The length and caliber of intrathoracic airways increases with lung volume, during growth. The caliber is a function of transbronchial pressure and, hence, of the volume and the elastic properties of the lung, and of the compliance of the air ways. Both airways and compliacence are influenced by flexion and extension of neck. (Mellissnos and Mead 1977)
2. Abdominal muscle generates force, which depends on the force-length relationship and, hence, varies with the level of lung inflation The speed with which maximal alveolar pressure is reached, depends on the force velocity properties of the expiratory muscles. (Potter *et al.,* 1971)
3. The lung stretching prior to the PEF manoeuvre; stress relaxation of viscoelastic lung elements is time-dependent, so that PEF immediately after stretching the lungs is higher than after a pause at total lung capacity. (D' Angelo *et al.,* 1994; Kano *et al.,* 1993) PEF is dependent on: the alveolar pressure generated by the subject; the flow resistance of intra and extrathroracic airways; and by the added resistance due to the instrument. In some subjects, the determinants of PEF may be the same as those which determine effort- independent flow, (Mead *et al.,* 1967) when expiratory flow is limited by the speed with which a pressure wave propagates in a dynamically compressed airway segment. (Pedersen *et al.,* 1996) thus health subjects PEF is determined by: the volume of lungs (which is function of the thoracic dimensions and, stature); by elastic properties of the lung; and by power and co-ordination of expiratory muscles (which can be enhanced by training). Hence males generate higher alveolar pressure (Schrader *et al.,* 1998; Leech *et al.,* 1983; Gaultier and Zinman 1983; Cook *et al.,* 1964; Smyth *et al.,* 1984; Wilson *et al.,* 1984) so can achieve higher values of PEF than females.

Factors affecting peak expiratory flow rate (PEFR)

1. Age: there is negative correlation of PEFR with age found in both sexes. PEFR was found to increase till third decade of life in males, and second decade of life in females. Later it started decline with each advancing year of life. (Ain *et al.,* 1983; Gregg and Nunn 1989; Brooks and Waller 1972; Amat *et al.,* 1977; Malik *et al.,* 1980)
2. Anthropometric measurements: standing height is best single predictor in childhood for PEFR. It is also related with weight(minimum correlation), body surface area(maximum correlation) and chest expansiblity.[7] PEFR is significantly lower in obese than non obese. (Kumar *et al.,* 2013; Heena Kauser *et al.,* 2014)
3. Sex: PEFR is higher in males than female. During pregnancy, the airways may also be affected by the fetal sex hormones. The mother's airways are less reactive if the fetus is a male. (Becklake and Kauffmann 1999) PEFR is more in hard manual worker than sedentary workers. (Ain *et al.,* 1983)
4. Environmental effect: impairment of PEFR was found in subjects of overcrowded area in both males and females as compared to moderately or open space. (Ain *et al.,* 1983) PEFR is consistently lower in smokers than non smokers in all age groups. In summer due to air pollution PEFR decline in children. (Taylor and Asthma 1994; Brown and Minns 1998)
5. Exercise: Training increases the PEFR by increase in respiratory muscle strength. (Diskshit *et al.,* 2005)

Advantage and disadvantage of a peak flow meter

1. The peak flow meter is a small, inexpensive, easy to use, portable, and hand- held , once taught does not require supervision.
2. It helps in diagnosing, helps in knowing progress of disease and self management of asthma. Even helps patient know what triggers his asthma.
3. Asthmatic patient often show daily variation in readings with fall in night and early morning. Fall of 15% PEFR of personal based is indicative of asthma.
4. PEFR is used as bronchial provocation test by exercise (about 6-8 min) in 'exercise induced asthma' especially in children
5. PEFR shows fall in occupational asthma during work, which is reversible after stoppage of work.
6. Helps in self- management of bronchial asthma by maintaining peak flow chart and personal based result and interpreted result as1.Safe zone- 80- 100% of personal best result. 2. Alter zone - < 80% - > 50% of personal best result. 3. Emergency zone - < 50% of personal best result. (Boggs *et al.,* 1998)
7. PEFR usefull in Guillain- Barre syndrome or in paralysis to predict involvement of respiratory muscle and to know its strength. (M Al- Amin Mridha *et al.,* 2002)
8. Peak flow meter has limitation; it assesses the airflow in the larger airways and not in the medium and smaller airways. There is change in readings indifferent models.

Conclusion

Peak expiratory flow rate though ancient, is a simple way to record ventilator y function test. It helps in self management, but under guideness of physician of asthma and other

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