The peak flow meter and its use in clinical practice

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Introduction

Bronchial asthma is a disease that causes significant morbidity and mortality. It is projected to increase at an alarming rate with an estimated prevalence of 400 million by the year 2025, as contrasted to 300 million at present. Monitoring this disease involves both subjective and objective modalities. The peak flow meter is the one of the means of objectively assessing and monitoring the airway function of the patient with bronchial asthma.

It has been said that the peak flow meter is to the asthmatics, what the sphygmomanometer is to the hypertensive. Most clinicians are, however, not skilled in the use of this simple instrument and its in partnership with the asthmatic, to develop a personalised asthma management plan in order to achieve effective control. This article thus seeks to highlight the importance of the peak flow meter and its use in clinical practice.

A peak flow meter is a small hand-held device that measures how fast a person can blow air out of the lungs when there is forceful exhalation, after maximum inhalation. This measurement is called the 'peak expiratory flow' (PEF). The peak flow meter helps to assess the airflow through the airways and thus help to determine the degree of obstruction along them.

The measurement of PEF was pioneered by Dr Martin Wright who produced the first meter specifically designed to measure this index of lung function. Since the original design was introduced in the late 1950s, and the subsequent development of a more portable, lower-cost version (the 'Mini-Wright' peak flow meter), other designs and copies have become available across the world. Brands of electronic peak flow meters are also being marketed.

Description

A peak flow meter (Figure 1) consists of a housing which has within it a channel along which a pointer is movable to a distance dependent on the lung function of the patient using the meter. Positioned adjacent to the channel, are two or more indicators which move along an axis parallel with the channel. Each indicator presents to view, two visually distinguishable areas defining a boundary that can be set at a point along the path of the pointer to indicate limit positions relating to lung function. This indicates to the user when to take remedial action.

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Types of peak flow meters

There are several brands of peak flow meters available which all perform the same function. However, there are two major types: the low-range peak flow meter for small children between 4 and 9 years of age, and for adults with severely impaired lung function; and the standard-range peak flow meter for older children, teenagers, and adults.

It is important that the doctor or healthcare provider prescribes the appropriate device for each individual. Adults have larger airways than children. If given a low-range peak flow meter, they will continually have maximum peak flow rates even when having severe shortness of breath. This may jeopardise proper management; they therefore need the much larger standard range.

What is a normal peak flow rate?

Normal peak flow rates vary according to age, height, and sex. However, a patient's normal score should be within 20% of a person of the same age, sex, and height who does not have asthma. There are published standardised normal values which were calculated by comparing asthmatics with a set of age- and sex-matched controls.

The 'normal peak flow' or 'personal best' is the highest consistent peak flow reading over a 2–3-week period when the patient does not have asthma symptoms. It serves as a standard against which other readings are measured. By checking the patient's personal best when he does not have symptoms, changes can be recognised and reduced PEF can be

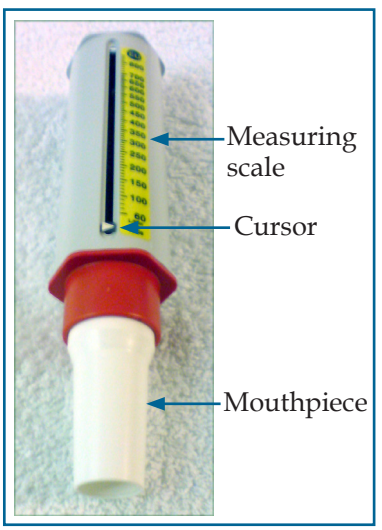

Figure 1 A peak flow meter

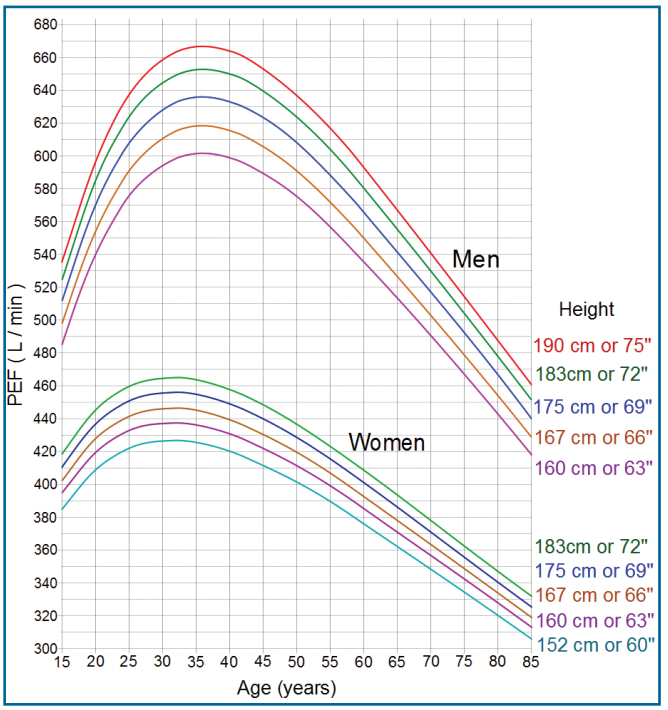

Figure 2 Normal values for PEF (EN 13826 or EU scale)

monitored. In addition, when the PEF remains at a high-level, it helps to reassure the individual that the asthma is under control.

It is good to note that every asthma patient's personal best or normal PEF is unique to them. It is the duty of the physician to assist the patient to determine what their personal best is. Figure 2 shows an example of a nomogram which can assist in estimating the best peak flow reading of the subject.

Clinical use of the peak flow meter

Diagnosis of asthma

Variability

One of the hallmarks of asthma is variation in airflow obstruction. Considerable variations in PEF over short periods can be recorded by measuring the peak flow twice daily – preferably mornings and evenings. Patients with asthma often show diurnal variation with readings falling sharply in the night or early mornings, the so-called 'early morning dips'. Variation of at least 15% of established maximum is assumed to be indicative of asthma.

Bronchodilator response

Another characteristic of asthma is reversibility with inhaled bronchodilators. If the patient inhales a short–acting β2 agonist such as salbutamol, terbutaline sulfate, or anticholinergics, a bronchodilator response greater than 15% in PEF is indicative of asthma.

Exercise testing

Exercise is known to induce bronchospasm in over 80% of asthma patients. Exercise challenge has been in use for several years in the diagnosis of asthma, especially in children. The standard technique is to exercise the asthma patient for about 6–8 minutes on a treadmill, or in some cases free running on an open field; a fall of PEFrate greater than 15% is indicative of asthma (see Figure 3).

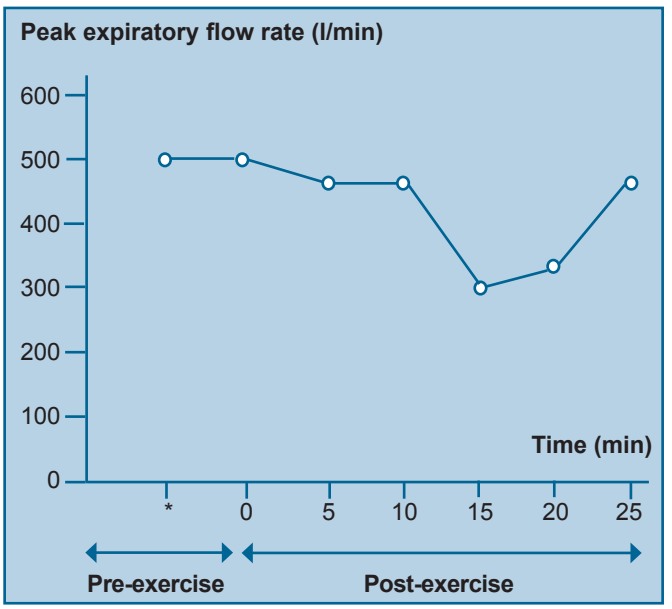

Figure 3 Exercise testing showing a 40% decrease in PEF after 15 minutes of exercise

Occupational asthma

Demonstration of work-related asthma can be done by frequent readings of the peak flow every 2 hours throughout the day or when the patient is awake, for about 4 weeks. However, a reasonable diagnosis can be made by having patients record their peak flow reading

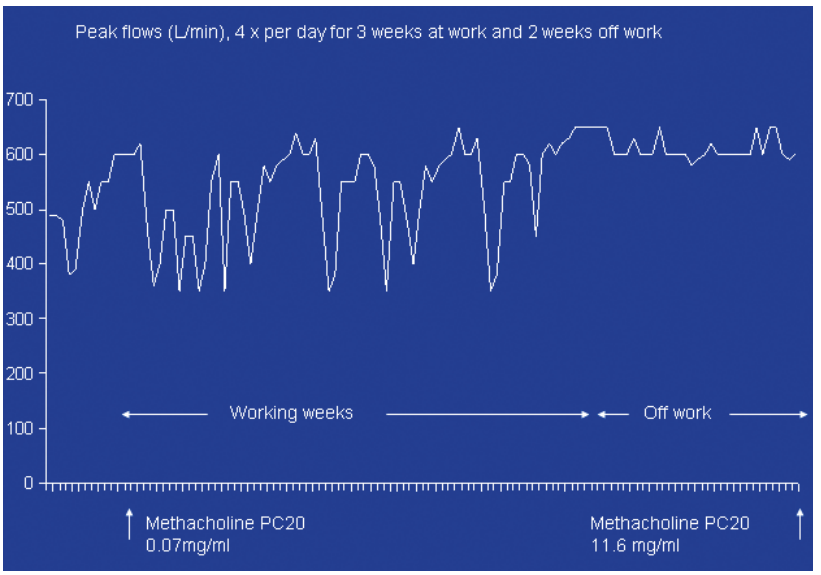

Figure 4 Peak flow meter reading of a foam worker with occupational asthma from toluene diisocyanate (TDI)

three or four times daily, preferably before the first shift, after a break, at the end of a shift, and before reporting for work the next day. In occupational asthma there is a progressive fall in peak flow rates over several days and failure to return fully to normal. There is also progressive recovery on work cessation over several days, with or without medication (see Figure 4).

Monitoring disease progress

The peak flow measurement can be used to decide the suitability of patients for discharge after an acute severe attack. Large dips in readings are an indication that their asthma is not yet under control, and calls for continued modification of therapy. The diurnal variation should also be less than 25%. Patients should be discharged if their PEFR has returned to normal or at least 75% of the predicted or best value.

Self-management plan

Asthma is an unpredictable disease, and this is especially so with those whose asthma is severe or unstable. These patients are better managed with an asthma self-management plan using a diary and a peak flow meter. A simple plan is to stick coloured tape on the peak flow meter to correspond to agreed zones or levels, with specific instruction of what to do at each level. Before the asthma patient can use this guide, he/she would have recorded his peak flow reading consistently morning and evening for at least 2 weeks and thus know his estimated best PEF values.

Usually the traffic light colour code is used. Figure 5 summarises what each code indicates and the required action by the patient.

Green zone: The peak flow reading is between 80–100% of the patient's personal best. This is the 'all-clear' zone. There are no symptoms, he can do normal activities and have a sound sleep. He should continue his usual treatments (bronchodilators when needed with or without regular inhaled seroids.

Yellow zone: Peak flow reading is between 50–79% of patient's personal best. This is the 'caution' zone. Asthma may be getting wrose. The patient may be coughing, wheezing, sleeping poorly, or having restricted activities. He should take action to gain control and needs to adjust his medications, as recommended by the doctor.

Red zone: Peak flow reading is less than 50% of the patient's best. This is an asthma emergency! Patients may be coughing, dyspnoeic and having sleep disturbances with frequent awakenings in one night and most nights. He may be unable to complete sentences in one breath. The patient is advised to take a reliever medication such as the short-acting β-2 agonist medication and start an oral dose of steroids. He should call the doctor or go to hospital immediately if these symptoms persist or he develops blue lips or fingers, or if the peak flow is still in the Red Zone 30 minutes later.

Figure 5 An example of a self-management plan for asthma

How to use the peak flow meter

The patient must be well instructed and if possibe have a practical demonstration so as to get the correct reading. Table 1 highlights the steps involved in using the peak flow meter.

Table 1 How to use the peak flow meter

1. Set the cursor to zero. NB Do not touch the cursor when breathing out.
2. Stand up and hold the peak flow meter horizontally in front of the mouth.
3. Take a deep breath in and close the lips firmly around the mouthpiece, making sure there is no air leak around the lips.
4. Breathe out as hard and as fast as possible.
5. Note the number indicated by the cursor.
6. Return cursor to zero and repeat this sequence twice more, thus obtaining three readings.

The highest or best reading of all three measurements is the peak flow at that time. The highest reading should be recorded in the patient's daily asthma diary or recorded on a peak flow chart. To ensure results of the peak flow meter are comparable, the patient is advised to use the meter in the same way each time and at the same time each day.

How to chart the peak flow readings

The peak flow rates should be recorded on a peak flow chart. The patient is required to chart the highest of three readings. This is the best for the period. A typical chart has dates with AM and PM, a left margin with a scale starting from 01/min at the bottom and ending with 6001/min at the top. It should also contain space at the bottom to record symptoms, possible triggers, and medications used. Figure 6 is an example of a peak flow chart showing the progression in the peak flow rates of an asthmatic before and after treatment.

When to use the peak flow meter

A peak flow meter should be used regularly to monitor asthma control. It is also a valuable tool to monitor the effectiveness of short-term bronchodilators (rescue medications) during an acute episode of asthma. It is therefore recommended for use:

- every morning before the patient takes his asthma medications and in the evenings. It is preferable to use the peak flow meter at the same time every day and record symptoms;
- when having asthma symptoms that either wake the patient at night or are increased during the day, or when the patient needs rescue medication;

- during an attack of asthma;
- after taking medication for an asthma attack.
- as recommended by the health practitioner.

What are the advantages of a peak flow meter?

- The peak flow meter is useful in that it is small, inexpensive, easy to use, portable, and hand-held, and does not need to be plugged in. Once a patient has been taught how to use it he does not need supervision.
- It is useful for diagnosing asthma.
- It helps to monitor the progress of disease, and is useful in self-management of asthma. When properly used it can recognise early changes and reveal narrowing of the airways well in advance (hours or even days) of an asthma attack. This helps the patient to take his rescue medications and pre-empt an attack.
- It enables the asthma patient to measure the day-to-day variation in his breathing accurately.
- It helps to identify what is going on in the lungs rather than guessing by how the patient feels.
- It shows the effectiveness of the asthma medication and management plan.
- It keeps a record of how the patients have been between clinic attendance.
- It helps the doctor know when to adjust, add to, reduce, or stop asthma medications.
- It could help the patient learn what triggers his asthma.

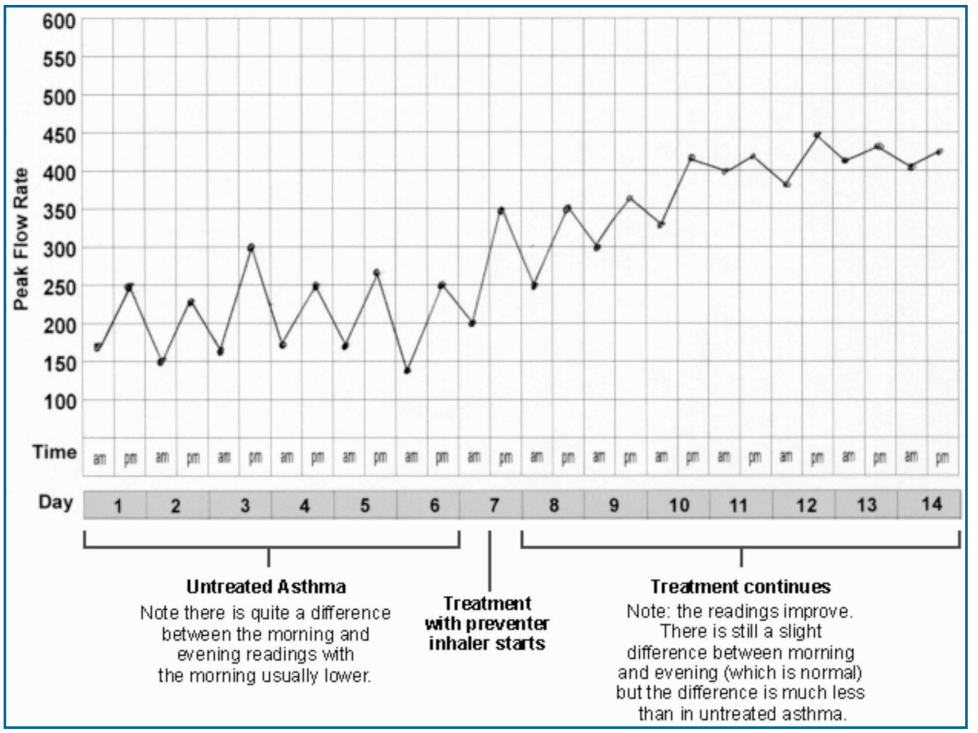

Figure 6 An example of a peak flow chart

Limitations of a peak flow meter

The peak flow meter has some limitations. Results are sometimes not reproducible over a long period and there may be inter-model variation in the values of readings obtained. It is also effort dependent. It primarily assesses the airflow in the larger airways and not in the medium and smaller airways and thus can underestimate the degree of airflow limitation, particularly as airflow limitation and gas trapping worsen.

It is good to note that measurement of PEF is not interchangeable with other measurements of lung function such as FEV1 (forced expiratory volume in 1 second).

Conclusion

Peak flow meters are available in medical equipment and drug stores worldwide and can be acquired without prescription. It is advisable for the patient to consult his doctor before obtaining a peak flow meter, this will ensure that he is getting the right type and the physician will be able to give step-by-step instructions on how to use the device for maximum effect.

It is good to know that measuring the peak flow is just one step in gaining control of asthma. It should not be a substitute for regular medical care and clinic visits. The patient must work in partnership with his physician to develop an effective self-management plan, learn to avoid his asthma triggers and use his asthma medication as prescribed. It is pertinent, therefore, for the physician to be familiar with the peak flow meter and its appropriate use.

Further reading

- Global strategy for asthma management and prevention (updated 2009): Global Initiative for Asthma (GINA). URL:http://www.ginasthma.org; 2009.
- Sawyer G, Miles J, Lewis S, et al. Classification of asthma severity: should the international guidelines be changed? *Clin Ex Allergy* 1998; 28(12): 1565–70.
- Erhabor GE. Pulmonary function tests: spirometry and peak flow in clinical practice. Waltodany Publishing Press, 2010.
- Eid N, Yandell B, Howell L, Eddy M, Sheikh S. Can peak expiratory flow predict airflow obstruction in children with asthma? *Paediatrics* 2000; 105(2): 354–8.
- Reddel HK, Marks GB, Jenkins CR. When can personal best peak flow be determined for asthma action plans? *Thorax* 2004; 59(11): 922–4.
- Reddel HK, Salome CM, Peat JK, Woolcock AJ. Which index of peak expiratory flow is most useful in the management of stable asthma? *Am J Respir Crit Care Med* 1995; 151(5): 1320–5.
- Dekker FW, Schrier AC, Sterk PJ, Dijkman JH. Validity of peak expiratory flow measurement in assessing reversibility of airflow obstruction. *Thorax* 1992; 47(3): 162–6.
- Boezen HM, Schouten JP, Postma DS, Rijcken B. Distribution of peak expiratory flow variability by age, gender and smoking habits in a random population sample aged 20-70 yrs. *Eur Respir J* 1994; 7(10): 1814–20.