PEAK EXPIRATORY FLOW (PEF) is a commonly used and simple test of lung function. It is defined as: ‘the highest flow achieved from a maximal forced expiratory manoeuvre started without hesitation from a position of maximal lung inflation’ (Miller et al 2005). It is measured in litres/minute and occurs early in a forced expiration – within the first tenth of a second. The major contribution to PEF is airflow from the larger generations of airways. Its limitations are that it does not measure lung volume and it is not sensitive enough to detect early airflow obstruction in small airways, which is the hallmark of chronic obstructive pulmonary disease. The main use of PEF is for: the diagnosis and monitoring of asthma; as part of a personalised asthma action plan; assessing the severity of an asthma attack; and monitoring response to therapy in asthma.

It is of limited usefulness in other respiratory diseases and children under the age of 5-6 years are usually unable to produce reliable, reproducible and meaningful recordings.

PEF can be measured with a flow measuring spirometer, but is most commonly measured with a PEF meter. There are a wide variety of cheap, portable meters available on NHS prescription. The Mini Wright meter is one of the most common (Figure 1).

Recording peak expiratory flow

Instruct the patient to take a maximal breath in and to blow as hard as he or she is able. It is also helpful to demonstrate the technique to the patient before asking him or her to try. PEF can be measured with the patient in either the sitting or standing position, as long as subsequent or serial recordings are done using the same position.

Set the pointer on the meter to zero by pushing the pointer down. Ask the patient to stand, or sit upright. He or she should hold the meter horizontally, firmly but without squeezing the body of the meter because this could impede the movement of the pointer. The air exhaust holes at the end of the meter need to be kept clear and fingers should not obstruct the movement of the pointer. The patient should be instructed to:

- Take a maximum breath in (inspiration).
- Then immediately place the mouthpiece of the meter between the teeth so that the tongue and teeth do not occlude it.
- Then blow (exhale) as hard as he or she can down the meter.

There should be the minimum of delay between completing inspiration and blowing down the meter and the exhalation should be a short, sharp ‘huff’ with an open glottis. Note the reading on the meter. Allow the patient time to recover and repeat the test a minimum of a further two times. The three readings should be within 20 litres/minute of each other. If the variation between efforts is greater than this, a further two efforts can be undertaken as long as sufficient recovery time between efforts is allowed. Further efforts are unlikely to be helpful if reproducibility is not achieved with five efforts (Miller et al 2005). The highest reading is recorded.

PEF measurement in patients with unstable asthma may produce bronchoconstriction. If repeated measurements produce progressively lower recordings, testing should be stopped.

Errors in technique

PEF is an effort-dependent test. Errors include:

- Failing to take a maximal inhalation.
- Holding the breath at maximal inhalation and delaying blowing into the meter.
Predicted normal reference values

The reference value for PEF in an adult is dependent on age, gender and height. The most widely accepted reference values were determined from large population surveys conducted in the 1980s (Nunn and Gregg 1989).

A value of more than 80% of the reference value is usually considered to be normal, but there is a wide variation in the normal reference range. Values of 100 litres/minute on either side of the reference value can be considered normal. If possible, it is better to use the patient’s best ever value to determine whether or not the value is normal for that particular individual.

To calculate the patient’s PEF as a percentage of the reference value or best ever reading:

\[
\text{PEF recording} \times 100
\]

Reference value or patient’s best

In a patient with asthma, a PEF reading below 50% of the reference value or best ever recording indicates a severe attack. Values of less than 33% indicate a life-threatening attack (British Thoracic Society (BTS) and Scottish Intercollegiate Guidelines Network (SIGN) 2005).

Asthma is a variable condition and a single ‘normal’ PEF reading does not exclude asthma. Serial PEF readings, taken morning and evening over a two or three-week period, can be used to confirm a diagnosis. A diurnal variation of more than 20% best (calculated using the formula suggested) with a minimum change of at least 60 litres/minute, ideally for three days in a week over the two-week period, is considered diagnostic (BTS and SIGN 2005). To calculate diurnal variability in serial PEF measurements:

\[
\text{Highest PEF reading-lowest PEF reading} \times 100
\]

Highest PEF reading

Peak expiratory flow scales

The original Wright McKerrow PEF meter scale was found not to accurately reflect flow, particularly at the higher and lower ends of the range. All PEF meters now sold in the European Union (EU) use a new scale which complies with EU standard EN 13826. There are, however, some old meters still in use with the original scale. The reference values for PEF determined by Nunn and Gregg (1989) used the Wright McKerrow scale. These values have been adapted for use with the new EU standard meters. Adapted reference values and an online conversion facility are available at www.peakflow.com. The reference values for the Wright McKerrow and EU scale are not interchangeable – ensure you use the appropriate values for the equipment.

Care and replacement of equipment

Peak flow meters on prescription are labelled for single patient use. They should not therefore be used between patients. Meters labelled for multiple patient use are available for use in clinics. PEF meters should be cleaned and disinfected regularly following the manufacturers’ instructions. In healthcare settings where meters are used between patients, a log should be kept of cleaning and disinfection procedures and disposable, one-way mouthpieces that prevent a patient from inhaling through the meter should be used. Meters should be replaced annually. With regular use the spring becomes slack and the meter becomes inaccurate. PEF readings will vary between meters and different makes of meter. It is good practice to use the same meter for follow-up recordings; preferably the patient’s own.

Conclusion

Spirometry has superseded PEF measurement in many clinics. However, PEF measurement is easy and quick to teach and less prone to error in the hands of non-expert patients, and health professionals. When the procedure is explained and the patient is encouraged to perform the test well, it has a useful role to play in the diagnosis and monitoring of patients with asthma.

References

