Measuring peak expiratory flow rate: what the nurse needs to know

Rationale and key points
This article provides information on monitoring a patient’s peak expiratory flow rate. It explains the rationale for measuring the peak expiratory flow rate, provides guidance for nurses to undertake this investigation and offers advice on how to instruct patients in the use of this technique.

- Measuring the peak expiratory flow rate is an inexpensive, straightforward and useful clinical investigation that enables fluctuations in the patient’s respiratory effort to be monitored over time.
- The peak expiratory flow rate is used for the diagnosis, monitoring and assessment of the severity of respiratory compromise, particularly in patients with asthma.
- The nurse can enable significant improvements in patient care by providing patient education on the correct technique, and by accurate assessment and recording of the peak expiratory flow rate.
- The nurse should advise the patient on the action required if variation between readings occurs, where the patient is required to monitor their condition at home.

Keywords
assesssment, asthma, clinical investigations, peak expiratory flow rate, pulmonary function, respiratory care

Learning outcomes
After reading the article you should be able to:
- Understand the clinical relevance of peak expiratory flow rate in asthma management.
- Demonstrate the correct use of a peak flow meter to monitor the peak expiratory flow rate.
- Explain the importance of self-monitoring the peak expiratory flow rate in patients with asthma.
- Provide advice to patients with established asthma on how to measure and record peak expiratory flow rates, and what to do if a sudden drop in the expected value is observed.

Peak expiratory flow rate
The peak expiratory flow rate is a pulmonary function test undertaken using a peak flow meter (Figure 1); it measures the maximum flow of air that a patient can expel from the lungs following a full inspiration (Riley 2016). A single peak expiratory flow test cannot be used as a diagnostic tool. However, if the test is repeated, and a variation of more than 20% is observed, this can help to diagnose asthma (British Thoracic Society (BTS) and Scottish Intercollegiate Guidelines Network (SIGN) 2016).

The peak expiratory flow rate reading will be lower when the airways are obstructed, as in the case of a patient experiencing an acute asthma exacerbation. The frequency of readings depends on the indication for measuring the peak expiratory flow rate and the patient’s condition (Branch and Coffey 2009). Spirometry is the preferred initial test to assess the presence and severity of airflow obstruction in adults (BTS and...
SIGN 2016). However, it can only be used in clinical settings and the results require interpretation by healthcare professionals familiar with the procedure. Spirometry is a specific investigation that can determine whether airflow resistance results from obstruction or restriction, which is fundamental to diagnose the underlying condition (Table 1) (Hughes 2011).

The peak expiratory flow rate is a relatively straightforward measurement to obtain, provided the patient is taught the correct technique. Therefore, it can be used in hospital wards or outpatient departments, or by the patient at home. The nurse can enable significant improvements in the care of patients with asthma by undertaking accurate peak expiratory flow rate assessment and recording, and also by providing education on effective technique and advice on the action required if variation between readings occurs. Specific intervention by an asthma nurse has been shown to increase patient knowledge of asthma management (Morice and Wrench 2001).

Indications

Measuring peak expiratory flow rate is a quick, simple and cost-effective means of assessing the severity of airway obstruction. Serial measurements enable the severity of airway obstruction and response to treatment to be quantified (Slavin and Reisman 2002). The recordings can be documented in a peak flow diary, and used to assess the effectiveness of pharmacological interventions or to review individual treatment plans. There is no single diagnostic test for asthma; diagnosis is confirmed where there is variable airflow obstruction in the presence of more than one of the following symptoms: wheeze, breathlessness, chest tightness and cough (BTS and SIGN 2016).

Measuring and recording peak expiratory flow rate

Preparation and equipment

» The nurse should ensure the appropriate equipment is available, including:
  – Peak flow meter.
  – Disposable mouthpiece.
  – Observation chart to record the readings.

» The nurse should explain the procedure to the patient, and include a demonstration if necessary. It is important to ensure patient understanding, promote concordance and obtain valid consent for the investigation.

» The nurse should assist the patient into a comfortable standing or sitting position, because patient discomfort can affect respiratory effort (BTS and SIGN 2016).

Procedure

1. Use a clean peak flow meter with a new disposable mouthpiece to prevent cross infection.
2. Check that the peak flow meter pointer has returned to zero to ensure an accurate reading.
3. Ensure the peak flow meter is held horizontally and that the patient’s fingers are not obstructing the pointer (Figure 1), which might prevent it from moving, or result in a false reading.
4. Ask the patient to take a deep breath in, to close their lips around the mouthpiece, making a tight seal, and to exhale as hard and fully as possible into the mouthpiece, with a sudden, sharp blow (huff) (Branch and Coffey 2009). A full inspiration is required to assess
airflow obstruction. Ensuring a tight seal around the mouthpiece prevents air from escaping, which might result in an inaccurate reading. When the patient exhales, a piston inside the cylinder of the peak flow meter is pushed down, progressively exposing a slot in the top of the meter until the piston reaches a position of rest. The piston position is indicated by a pointer on a scale from 60–800L per minute.

5. Record the reading and return the pointer to zero.

6. Ask the patient to repeat the process twice more. The peak expiratory flow rate should be recorded as the best of three forced expiratory exhalations from total lung capacity. After the patient has taken a full inspiration, there should be a maximum pause of 2 seconds before exhalation (Quanjer et al 1997). This improves the reliability of the final recording.

7. Record the highest expiratory flow rate reading, and ensure documentation is completed in accordance with local policy and includes the time, date and an indication of any nebulised or inhaled therapy. Accurate records of assessment are a fundamental aspect of nursing care.

8. Discard the used mouthpiece, clean the peak flow meter according to local policy and wash your hands to reduce the risk of cross infection.

9. A wide variation, such as a sudden drop in the expected value compared to the previous personal best value, could indicate deterioration in the patient’s condition. If the procedure was performed in a hospital, inform medical staff of any concerns. If the procedure was performed in the community, follow the previously agreed individual patient protocol for management.

**Monitoring and documentation**

If the patient maintains an accurate record of their peak expiratory flow rate measurements in their peak flow diary, fluctuations in respiratory effort can be observed over time. A historical record of lower readings during symptomatic episodes, as compared to asymptomatic periods, provides objective confirmation of symptoms (BTS and SIGN 2016). This information can be used to identify early changes in the patient’s condition that require treatment, to help evaluate responses to changes in therapy, and to provide a quantitative measure of impairment. The peak expiratory flow rate can also be used to assess reversibility and variability in patients with asthma.

**Reversibility**

For patients with an established airflow obstruction, it may be helpful to monitor the peak expiratory flow rate to assess the reversibility of the patient’s symptoms or their response to treatment (BTS and SIGN 2016). The peak expiratory flow rate is recorded, and then repeated following administration of medication, such as a short-acting selective beta₂-adrenoceptor agonist bronchodilator, for example salbutamol. A significant increase in the peak expiratory flow rate of >60L per minute, as compared to the previous reading before bronchodilation medication was administered, indicates reversible airflow obstruction and supports a diagnosis of asthma (BTS and SIGN 2016). Regular monitoring of peak expiratory flow rate enables the patient and clinician to assess any improvement or deterioration in respiratory

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**TABLE 1. Obstructive and restrictive lung conditions**

<table>
<thead>
<tr>
<th>Obstructive lung conditions</th>
<th>Restrictive lung conditions</th>
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<tbody>
<tr>
<td>» Chronic obstructive pulmonary disease (chronic bronchitis, emphysema).</td>
<td>» Diffuse pulmonary fibrosis. This may be associated with occupational or connective tissue disease.</td>
</tr>
<tr>
<td>» Asthma. Spirometry may appear normal if asthma is controlled.</td>
<td>» Loss of lung tissue resulting from systemic lupus erythematosus, sarcoidosis or sickle cell disease.</td>
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<tr>
<td>» Bronchiectasis. This can be diffuse, as in patients with cystic fibrosis, or local, following tuberculosis.</td>
<td>» Chronic heart failure. The enlarged heart can restrict full lung expansion.</td>
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<tr>
<td>» Bronchiolitis, following a viral infection or connective tissue disease.</td>
<td>» Pleural or chest wall disease, for example pleural effusion, chylothorax or mesothelioma.</td>
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<tr>
<td>» Bullous lung disease. General or localised emphysema or alpha-1 antitrypsin deficiency.</td>
<td>» Respiratory muscle weakness, for example myopathy, muscular dystrophy, motor neurone disease or myasthenia gravis.</td>
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(Bourke and Burns 2011, Hughes 2011)
function over time and provides an indication of the effectiveness of treatment.

**Variability**

Variability is defined as alterations in respiratory function that occur throughout the day. Where this occurs or is suspected, the peak flow meter can be used at home to enable multiple measurements to be made and recorded at different times (Bourke and Burns 2011). The patient can monitor and record their respiratory function in relation to common factors that might trigger respiratory compromise, such as occupational exposure, pets and pollen. One characteristic pattern in asthma is a ‘morning dip’, where the peak expiratory flow rate values are lowest in the morning and then improve throughout the day. This is known as diurnal variability and is most apparent in patients with inadequately controlled asthma (Bourke and Burns 2011).

Variability is calculated as the difference between the highest and lowest recording and then expressed as a percentage of the average (BTS and SIGN 2016). A diurnal variation in peak flow is established by monitoring the peak expiratory flow rate twice daily at home for 2 weeks, known as a serial peak expiratory flow rate test. The patient records their readings in a peak flow diary, which helps to establish whether there are any patterns in variability, or whether respiratory function is stable. A diurnal variation of >20% from the patient’s average, together with a history of childhood wheezing and atopic symptoms, suggests a diagnosis of asthma (BTS and SIGN 2016).

**Interpretation**

Peak expiratory flow rate records should be interpreted with caution and with regard to the clinical context. They are more useful in monitoring patients with established asthma, than in making an initial diagnosis (BTS and SIGN 2016).

All those diagnosed with asthma should be offered education about managing their condition. This should include a written, personalised asthma action plan that is supported by regular professional review (BTS and SIGN 2016). In adults, personalised asthma action plans may be based on symptoms and peak expiratory flow rate recordings. Symptom-based action plans are generally preferable for children (BTS and SIGN 2016). The aim of asthma management is control of the condition; complete control is demonstrated by normal lung function, which is a peak expiratory flow rate of ≥80% of the patient’s predicted or personal best (BTS and SIGN 2016). A deterioration in a person’s peak expiratory flow rate to 50-75% of their previous personal best indicates a moderate asthma episode, while a reduction to 50% or less of their previous personal best can indicate an acute severe exacerbation (BTS and SIGN 2016). An acute asthma attack is sudden in onset, while a severe asthma attack requires medical attention.

**Factors that influence peak expiratory flow rate**

The peak expiratory flow rate varies according to the age, height, gender and ethnicity of an individual and how well their asthma is controlled. The average peak expiratory flow rate recorded for a typical adult male is approximately 500-650L per minute and for a typical adult female is 400-500L per minute (Hammond and Spurgeon 2015). The peak expiratory flow rate is also reduced in loss of pulmonary volume, for example following a pneumonectomy, during a pleural effusion or with respiratory muscle weakness, in addition to airflow obstruction (Hughes 2011).

It is useful to have a baseline reading, taken at a time when there is no respiratory compromise. The patient should know their baseline measurement, and understand what to do if there is any deterioration in this measurement. Interpretation tables are available in the clinical setting or online (see useful resources). However, readings should be interpreted with caution, in the context of clinical findings and knowledge of the patient’s usual readings.

**Benefits of peak expiratory flow rate measurement**

The main advantages of peak expiratory flow rate measurement are the portability.
of the device and its low cost (Bourke and Burns 2011). It is widely available and easy to use (BTS and SIGN 2016). The patient can be taught to measure and record their peak expiratory flow rate independently, at different times, and in different environments, so that variability in their respiratory function can be measured. Monitoring peak expiratory flow rate is also useful for patients who might underestimate the severity of their symptoms and become acutely unwell (BTS and SIGN 2016).

Limitations of peak expiratory flow rate measurement
Peak expiratory flow rate is non-specific and does not distinguish airflow obstruction from restriction (Hughes 2011). Measurement by spirometry is widely available in clinical settings. It is preferable to the measurement of peak expiratory flow rate, because it permits clearer identification of airflow obstruction and the results are less dependent on patient effort (BTS and SIGN 2016). Incorrect technique, patient concordance and effort are major factors in accurate measurement of peak expiratory flow rate. Coughing into the peak flow meter can lead to an erroneously high reading (Hughes 2011). Therefore, clear instruction, demonstration and monitoring are required to achieve optimum results.

The usual range of peak expiratory flow rate readings is wide, and the peak expiratory flow rate tables currently available are outdated and do not encompass ethnic diversity (BTS and SIGN 2016). Therefore, an alteration in an individual reading, such as a reduction from the previous recorded personal best value, is more meaningful than a single measurement or a comparison to predicted normal values.

Conclusion
Monitoring the peak expiratory flow rate is an inexpensive, straightforward and useful investigation that can indicate variations in the respiratory effort of patients. A reduction in peak expiratory flow rate is an effective indicator of worsening asthma. Patient concordance is essential for accurate measurements, where patients are required to monitor their condition at home. The nurse can enable significant improvements in the care of patients with asthma by undertaking accurate peak expiratory flow rate assessment and recording, as well as providing education on effective technique and advice on the action required if variation between readings occurs.

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