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Expiratory Flow Rate method (PEFR) measures the degree of obstruction in the airways. PEFR is a simple method that measures the level by which the peak flow readings are lower than usual. This is a sign that the airways may have deteriorated their functioning and that asthma could be exacerbating. Lung function tests are often done before and after taking a bronchodilator such as salbutamol to open the airways. If the lung function improves with the use of a bronchodilator, it is likely to be asthma. 

Methacholine or histamine challenge tests consist in provoking bronchoconstriction or narrowing of the airways by a methacholine or histamine stimulus. Histamine causes nasal and bronchial mucus secretion and bronchoconstriction via the H1 receptor, whereas methacholine utilizes the M3 receptor for bronchoconstriction. The degree of narrowing can then be quantified by spirometry. Subjects with pre-existing airway hyperreactivity, such as asthmatics, will react to lower doses of bronchoconstriction drug. This test may be used if the initial lung function test is normal. 

Fractional exhaled nitric oxide (FeNO) test appears useful to diagnose and monitor asthma, where the amount of nitric oxide present in patient breath is measured. If airways are inflamed – a sign of asthma – the nitric oxide levels are higher than normal. However, this test is not widely available.

At present, quantification of inflammation in the lungs is based on invasive (open lung biopsy (Chuang et al., 1987; Jarjour et al. 1998; Jeffery et al., 2000), bronchoalveolar lavage (Jarjour et al., 1998; Reynolds, 2000)) or semi-invasive (for example, induced sputum (Dworski et al., 2004; Green et al., 2002; Holz et al., 2000)) methods and the measurement of inflammatory markers in plasma and urine, which are likely to reflect systemic rather than lung inflammation. The analysis of exhaled breath condensate (EBC) is a relatively novel method with a good potential to become the preferred and completely non-invasive alternative to the currently practiced invasive and semi-invasive diagnostic methods for bronchial asthma. New approaches are based on attempting to identify robust biomarkers which could be utilized in establishing the diagnosis of asthma. The former studies investigated the predictive value of EBC pH for asthma, the latter chose to research hydrogen peroxide, nitrogen oxides, arachidonic acid derivatives, cytokines and others. Besides arachidonic acid derivatives, especially cysteinyl leukotrienes (cys LTs) have shown the most consistent results for the diagnosis of asthma (Hatipoglu & Rubinstein, 2004).

Thus, in the current clinical practice, spirometry and symptom scores are used to assist in the diagnosis of the disease severity and control in individual patients. EBC analysis and determination of concentration levels of the bronchial asthma biomarkers is an exciting new approach to monitoring lung inflammation. Many studies have attempted to associate changes in the EBC biomarkers – pH, hydrogen peroxide, arachidonic acid derivatives, especially cys LTs with diagnostic parameters, stratification of asthma severity, therapy effectiveness, etc. Because the technique is relatively inexpensive, it might be useful in large clinical studies and in clinical practice. In the near future, it might be possible to detect multiple asthma biomarkers in EBC (multimarker screening) to aid diagnosis, to predict the most effective therapy, and monitor the response to a treatment. The detection of elevated inflammatory mediators in EBC of subjects with relatively asymptomatic asthma and normal pulmonary function tests could offer a novel way monitoring the lung inflammation and perhaps initiating treatment in an earlier stage. They could also be helpful for the diagnosis of occupational asthma (Klusáčková et al., 2008) and monitoring work-related asthma control at the condition of either elimination from the workplace or reducing exposure, as the clinical benefit from workplace interventions is not sufficiently proven.
2. Exhaled Breath Condensate – A matrix for diagnostics

Every person breathes out 15 to 25 m³ of air per day. In addition to gas exchange, lungs are involved in many metabolic processes (defence against pathogens, airway clearance, arachidonic acid metabolism etc.). They contain different cell types responsible for various functions (respiratory regulation, defence reactions and surfactant production). The surface of lungs and airways is abundant with a number of substances (e.g. enzymes, tumour markers, antibodies, proteins, metabolites etc.) whose presence and concentration level reflects the physiological/pathological conditions of an organism. Metabolites generated in the lungs can be examined by invasive or semi-invasive methods - bronchoalveolar lavage (BAL), methods of induced sputum and open lung biopsy. These diagnostic methods impose a considerable strain on the patients and cannot be repeated as often as the efficient health monitoring would require. By contrast, the measurements of metabolite products in the EBC are non-invasive and conspicuously reflect the composition of the extracellular lung fluid (Piotrowski et al., 2007).

During the collection of an EBC, it is often assumed that the monitored biomolecules are merely contained in the gas phase of the exhaled air. This assumption neglects the fact that the exhaled air also contains a liquid fraction, i.e. aerosol which inevitably carries important biochemical information as well (Fig. 2). In addition to gases as nitrogen, oxygen, carbon dioxide or carbon monoxide contained in the gaseous phase, there are substances with a sufficient vapour pressure at the body temperature and the atmospheric pressure such as water, hydrogen peroxide, hydrocarbons and other volatile organic compounds. In parallel, there are substances insoluble in water which form binary systems with water in the epithels of lungs and airways. In this case, the vapour pressure of water and hardly volatile biomolecules add up, greatly facilitating the evaporation of biomolecules. As a consequence, these can be present in the vapour phase of the exhaled air. Eicosanoids (leukotrienes and prostaglandins) are the example of substances entering the exhaled air by this described mechanism. Molecules of water-soluble substances, for example vasoactive peptides, enzymes, DNA and proteins flow within the exhaled air as aerosol particles. They are released from the mucous surface due to a turbulent airflow throughout bronchi and bronchioles (Effros et al., 2004). EBC is a water-based matrix. The collection of an EBC sample is a simple, non-invasive procedure that can be beneficially applied especially to children (older than 3 years), seniors as well as patients with different disease-impaired health conditions.

Fig. 2. Generation of exhaled breath condensate. Occurring on the airways surface and in alveoli: (1) evaporation of volatile substances and substances insoluble in water forming a binary system with water on the airways surface and (2) aerosol particles carried away by the turbulent airflow. Aerosol droplets are collected in the exhaled air condenser, where condensation of the water vapour and other volatile substances occurs.