

The analysis of the exhaled air can be a useful tool in the diagnosis of many lung diseases, such as pneumonia, chronic obstructive pulmonary disease, asthma, cystic fibrosis, cancer and tuberculosis. Currently used clinical and laboratory methods for lung diseases diagnosis are time-consuming and also invasive (culturing bacteria from the collected biological material requires 24 to 48 hours), while early diagnosis is crucial for the implementation of appropriate therapy. As an alternative to the commonly used methods, the analysis of volatile metabolites in the breath offers many advantages, such as a short analysis time, as well as being completely non-invasive and painless.

The aim of the presented project is the assessment of the applicability of modern techniques of exhaled breath sampling for the non-invasive diagnosis of pneumonia. These techniques are based on the use of microextraction meshes and microextraction needles with filters. Modern microextraction needles with an additional filter, in contrast to the analytical methods used so far, enable a complete analysis of the exhaled air, taking into account volatile compounds as well as those in the form of microdroplets dispersed in the exhaled air as an aerosol.

The basic assumption of the project is that pathogenic microorganisms produce many different volatile organic compounds (VOCs), some of which are characteristic of a given species as a "biological fingerprint", indicating the presence of a specific pathogen. As a result of gas exchange in the alveoli, volatile biomarkers enter the exhaled air, where they can be determined even in real time using modern analytical techniques such as gas chromatography coupled with mass spectrometry.

The main objective of the project is to assess the possibility of using a new non-invasive technique of sampling exhaled air, based on the use of microextraction needles with filters, in the diagnosis of pneumonia. For the proper consideration of a research problem, the project is divided into three main stages:

1. Development of new analytical methods using microextraction needles with filters and microextraction meshes.
2. In vitro experiments with strains of pathogenic microorganisms aimed at identifying species-specific volatile metabolites.
3. Pilot clinical trials involving the analysis of breath collected from mechanically ventilated patients from the Intensive Care Unit of the 10th Military Hospital in Bydgoszcz in order to confirm the usefulness of the developed methods.

The proposed project will determine the clinical suitability of breath analysis using modern technology of microextraction needles with filters for non-invasive and immediate diagnosis of pneumonia. The non-invasive method enabling early detection of infection, full characterization of the exhaled air composition and potential identification of the etiological factor, significantly exceeds the currently available knowledge in the field of diagnosis of infectious diseases, which proves the innovative nature of this project.