Nuclear magnetic resonance based-metabolomics: a new frontier for the identification of predictive biomarkers of occupational exposure to risk factors

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Abstract

The aim of biological monitoring in humans is the identification of dose and effect biomarkers, highlighting early symptoms or dysfunctional situations that are still reversible. The knowledge of the subclinical effects related to occupational exposure could help to deeply understand the complex metabolic mechanisms that can lead to health damage, contributing to the identification of exposure predictive biomarkers for workers. In this sense, metabolomic approach is suitable for the purpose, as it is the science aimed at characterizing the response of a living organism's metabolic phenotype to the exposure to biotic and abiotic environmental perturbations. By quantifying low molecular weight metabolites (<1200 Da) in biological matrices, it is possible to obtain a characteristic and current metabolic profile that allows to identify different metabolic pathways involved in the response or adaptation phenomena. Among the biological matrices of interest, urine represents an alternative to blood, reflecting the health state of the organism and constituting a non-invasive investigation. In recent years nuclear magnetic resonance (NMR) spectroscopy has contributed significantly to the field of metabolomics [1,2]. Several characteristics of NMR, including its excellent reproducibility, the ability to identify unknown molecules and the ability to detect metabolites using intact biological samples, compensate for the low sensitivity, obtaining measurement of all the molecules concentrations in a single spectrum. Biological samples are analyzed by NMR, which uniquely identify the metabolites present both through one-dimensional and two-dimensional spectra. Subsequently, the quantitative analysis is conducted by comparing the integrals with respect to the internal reference standard at a known concentration. Multivariate and univariate statistical analyses are performed on data matrix, in order to identify and validate possible biomarkers. In the context of occupational exposure, the application of NMR-based metabolomics has already shown its usefulness in identifying metabolic phenotypes and predictive biomarkers, involved in the response to an environmental perturbation [3].

During the seminar the applications of NMR-based metabolomics will be illustrated in two different case studies, one aimed at identifying urinary metabolome and urinary biomarkers of oxidative stress in divers, the other aimed at evaluating the effect of welding fumes exposure on the urinary metabolic profile of metal carpentry workers.

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