

NMR as a Key Enabler of Metabolomics Integration into Clinical Chemistry.

Abstract:

Medical practice is undergoing a paradigm shift toward more personalized, precise, and patient-centered approaches. In this evolving landscape, clinical metabolomics emerges as a highly promising tool. Positioned at the intersection of genetics, environment, physiology, and pathology, metabolomics offers a unique window into the patient's phenotype and thus represents a powerful interface for personalized care.

Despite its potential, significant challenges must be addressed before metabolomics can fully transition from research settings to routine clinical use. Among these, the selection of the most adapted biofluids, the development of robust analytical and data management methodologies, the standardization of pre-analytical processes, the establishment of Biological Variation (BV) and Least Significant Change (LSC) for metabolites and the deeper understanding of the metabolome, including its physiological and pathological variabilities and functionalities, are key hurdles to overcome.

In this context, analytical platforms play a central role. Nuclear Magnetic Resonance (NMR) spectroscopy, due to its inherent strengths, particularly its robustness and quantification capabilities, stands out as a powerful tool in overcoming these obstacles. NMR's suitability for reproducible and high-throughput metabolic profiling positions it as a critical technology in the clinical translation of metabolomics.

This presentation will explore the major steps and challenges on the path to clinical implementation of metabolomics, with a particular focus on the contributions of NMR technology to the development of reliable protocols, sample analysis, and biological interpretation. Special attention will be given to matrix selection, pre-analytical standardization, and the characterization of temporal dynamics of the human metabolome.