Editorial Article

Metabolomics in Next-Generation Clinical Practice

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Metabolomics is a translational science deals with the molecular assessment of metabolites in the biological samples.[1] Metabolomics help to test the disease states by determining the metabolite biomarkers that may have a role in the pathophysiological mechanism. Advancement in metabolomics technologies contributes to the development of metabolomics tools in the detection of a diagnostic marker, a novel pathway through systems biology.[2] In general, metabolites act as a representative of the biological down-stream process of the gene, transcript, and protein expression. Metabolites reflect the Spatio-temporal phenotype of the living organisms.[3] Analyzing the metabolic changes between normal and diseased individuals provides information on disease mechanisms. Also, metabolites can provide insights into novel diagnostics markers for diseases.[4] These biomarkers will be helpful in the detection of disease stage, which is potential in addressing the current clinical need. Metabolomic technologies have improvised biomarker discovery, which supports personalized medicine.[5] The contribution of metabolomics in the clinical setup is enormous since the traditional approach can detect and analyze only a single metabolite at a time. Recently, the technological improvement in bioinstrumentation, helps in more accurate profiling of metabolites in bio-fluids using nuclear magnetic resonance spectroscopy (NMR), chromatography and mass spectrometry (MS), and other sophisticated analytical instruments. Currently, researchers are enabled to understand and investigate hundreds of metabolites in a single run.[6] Particularly, integrating the mass spectroscopy with chromatography provides more accuracy and reproducibility of profiling which are essential in medical fields. The metabolomic data derived from these high throughput techniques proven to be useful in diagnosis and disease management.[7] Gaining utility of these high throughput techniques which provide high sensitivity and accuracy and significant reproducibility show potential value in clinical care. Detection of a complex disease at an early stage will be a vital target to treat and for better clinical outcomes. Metabolites act as a potential indicator of pathological states that leads to the discovery of early diagnostics markers for a disease that help to determine the disease progression.[8] Additionally, metabolomics provides the development of the non-invasive diagnostic method, which may be cost-effective and rapid with high sensitivity and specificity.[9] Considering the importance of metabolomics in a clinical setting, this editorial elaborates on the utility of metabolites for the early detection, monitoring and therapeutic response in patients with the disease.

Biomarkers used in preclinical disease are crucial that helps in preventative therapies. Detection of any diseases at early stages is fundamental for successful disease management and treatment. With emerging technologies, the discovery of biomarker becomes an interesting part of research and development. Change in metabolites levels in bio-fluids such as a serum, CSF, urine and saliva considered as biological indicators of variations in disease pathology.[10]

Recently metabolomics has integrated with systems biology that interconnects metabolomics with other omics data such as genomics, transcriptomics, proteomics and metallomics for various clinical research purposes. Particularly, implementing systems biology derived from metabolite profiling suggest the development of personalized therapies for more efficient treatment of disease.[11-14] Current development in technologies made detecting the levels of hundreds of metabolites in bio-fluids in very limited time, which help in clinical application. Achievable application benefit of metabolomics was noticed in diseases like Alzheimer's, Parkinson's, diabetes and cancers. In Alzheimer disease's, metabolomic profiling of sphingolipid species showed elevated sphingomyelin and hydroxysphingomyelin in the brain and blood. These sphingolipids are linked with several molecular pathways, including amyloid-β metabolism, acetylcholine biosynthesis, calcium homeostasis, and neuronal death.[15,16]

Similarly in Parkinson's disease, we showed the change in serum metabolites of mitochondrial mechanism through light towards early diagnosis.[17] Also in cancer, a study showed an involvement of evaluated, L -tryptophan, arachidonic acid, deoxycytidine tri-phosphate, and pyridinoline in a patient with prostate cancer in response to endocrine therapy that linked with the role of cholesterol in the progression of prostate cancer.[18] In type 2 diabetes, change in serum arginine, alanine, proline, isoleucine, hexose, valine, tyrosine, and phosphatidylcholine diacyls were noticed, that correlated with insulin resistance and lipid profiles which show the association of metabolites with type 2 diabetes risk factors.[19,20]

Overall, metabolomics has shown the potential to understand and map the early molecular changes in pathogenesis that gives an opportunity to identify predictive markers to diagnosis and to start earlier treatment procedures. Also, metabolomics is the interdependent outcome of genomics, transcriptomics, and proteomics that assist in providing systematic behavior of molecules in both health and disease. Integrating the concepts of metabolomics in every step of the drug discovery and development process will help in basic understanding of pharmacokinetics and dynamics. Successful contribution of metabolomics in diagnosis, prognosis and treatment has created an essential role for metabolomics in clinical practices.

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