

EDITORIAL

MOLECULAR MEDICINE: A PARADIGM SHIFT IN CLINICAL SCENARIO

Shumaila Usman, Talat Mirza

Department of Research, Ziauddin University, Karachi

Spectacular advances have been made in molecular medicine during the last few decades including the mapping of human genome project which has revolutionized the understanding of basic molecular mechanisms involved in the etio-pathogenesis of most of the diseases. The completion of Human Genome Project disclosed about 90% of the human genome. This draft of human genome sequences has identified at least 38,000 genes and opened the door for genomic medicine and molecular studies. However, more investigation about the potential function and interaction of these genes was required to improve the clinical information in medicine¹.

In 1949, Linus Pauling laid the foundation of Molecular Medicine in his paper on Sickle cell anemia, by showing the difference in hemoglobin's electrophoretic mobility and between the normal and sickle cell anemia's patient with the conclusion that the defaulted protein structure is the driving force for the disease². Moreover, he also linked the hemoglobin structure with the mode of inheritance. This idea shifted the pathologic basis of disease from cellular to molecular level, and paved the way to explore and relate the molecular genetic mechanisms as the basic pathology, opening a new area of investigation with a thought of molecular medicine.

Molecular medicine is a collective application of molecular genetics and molecular biology which provides brief knowledge about the normal cellular processes and disease pathogenesis at the molecular level by utilization of modern molecular biology techniques. It emphasizes more on cellular and molecular phenomena and interventions rather than the previous conceptual and observational focus on patients and their organs. It is a comprehensive field which utilizes biological, physical, chemical, bioinformatics and medical techniques and aims to provide an insight to researchers in regard to the development of molecular biology tools and identification of molecular targets for the diagnosis, prognosis and treatment of a diverse number of human diseases.

Modern technologies such as DNA sequencing, microarray and proteomics enabled us to study thousands of genes and proteins simultaneously which is helping us to generate fresh hypotheses about the importance of genes and proteins in the patho-physiological conditions. Genome based research has empowered the development of extremely effective diagnostic tools to understand the people's health requirements based on their genetic makeup that will lead to a very powerful form of preventive medicine. Tremendous advances have been made in terms of identification of potential sites of disease intervention as targeted therapy and personalized medicine approach that would affect the future practice in medicine. Recent encroachments in genomics and modern technology have given a major insight into the etiopathogenetic mechanisms of disease and scientists are now closely investigating to bring new treatment options by using small molecule inhibitors, inhibitory RNA, target specific monoclonal antibodies and anti-sense oligonucleotide probes, in this era of precision medicine³.

Cancer is a major focus of the precision medicine to find the most accurate and effective management to each patient based on their genetic makeup and thus avoids the idea of "one-size-fits-all" in terms of cancer treatment. Several evidence support the idea of precision medicine that have already substantially improved the lives as compared to conventional chemotherapies⁴.

In this modern biological era, OMICS approach is considered as an important tool in the discovery of new biomarkers and molecular signatures with potential value in clinical practice. It provides better understanding at genomics (genome), transcriptomics (transcriptome), proteomics (proteome), and metabolomics (metabolome) levels of a biological system⁵. Fortunately, the recent advances in technology have hastened the biomarker discovery from the complex realm of molecular pathology by using metabolomics approach and it is now considered as one of the emerging branches in the diagnosis⁶.

Translational medicine enabled the opportunity to apply these cutting edge research discoveries, obtained from the basic research to clinical applications that evolve the classic "bench-to-beside" approach for the

prevention, diagnosis and treatment of diseases⁴. There is a dire need to link the gaps in translation of molecular biology's novel concepts into robust applications in the clinical practice. Investigation of the effect of genotype on disease countenance and evaluation of the effect of genotype on therapeutics are likely to be primary and important goal. Responding such questions requires strong clinician scientist collaboration to identify improved diagnostic and therapeutic approaches.

The field of molecular medicine is often stated as "tomorrow's medicine" as it is changing numerous aspects of therapy with medical sciences including the precision and probability of diagnostic procedures for personalized targeted therapeutic approach ultimately resulting in a higher degree of translation of new mechanistic insights into effective means of diagnosis and treatment³. However, if we fail to accept the advantages of molecular medicine, there will be no progress in spite of the availability of modern molecular technologies. Therefore, one of the most important challenges is awareness and acceptance of the physicians about the importance of molecular medicine in the practice and therapeutic development.

It must begin with the simplest step to incorporate clinical aspects of molecular medicine in the curriculum of undergraduate and postgraduate courses. The emphasis should be on bedside oriented molecular pathology with diagnostic implications and clinical relevance. A real paradigm shift would take place after integration of molecular and genetic studies in Masters and PhD program of clinical faculty, promoting working relationship between physicians and scientists. A number of medical institutes are already offering "molecular medicine" programs worldwide. We have entered a new age of discovery where the understanding of genome will revolutionize our concept of health and disease to improve the human health condition in remarkable ways. The molecular era is here to begin and change is predicted in the future, in terms of molecular medicine for the diagnosis, prognosis and treatment of diseases.

REFERENCES

1. Semsarian C, Seidman CE. Molecular medicine in the 21st century. *Int Med J* 2001; 31(1):53-9.
2. Bujard H, Grivel, L. EMBO Molecular Medicine—where molecular biology meets clinical research. *EMBO Mol Med* 2009; 1(1): 2–3.
3. Gannon F. Molecular medicine: trendy title or new reality? *EMBO Rep* 2003; 4(8): 733.
4. Shin SH, Bode AM, Dong Z. Precision medicine: the foundation of future cancer therapeutics. *NPJ Precis Oncol* 2017; 1(1): 12.
5. Lestón JS, Dios PD. Diagnostic clinical aids in oral cancer. *Oral Oncol* 2010; 46(6): 418-22.
6. Zhong L, Liu Y, Wang K, He Z, Gong Z, Zhao Z, et al. Biomarkers: paving stones on the road towards the personalized precision medicine for oral squamous cell carcinoma. *BMC Cancer* 2018; 18(1): 911.