Mini Review

Precision medicine: A revolution in the making

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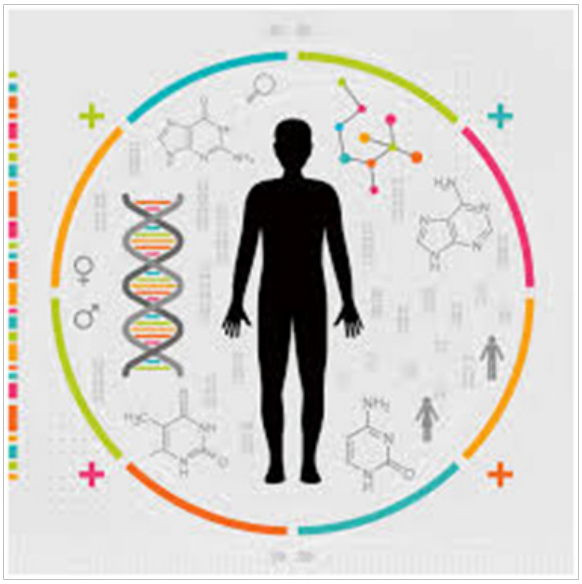
Introduction

At present, far too many diseases do not have proven preventions or treatments. There is a dire need to explore into the biological, environmental, and behavioral causal factors of these diseases. Precision medicine (PM) is a new science that takes into account the prevention and treatment of diseases by addressing specific changes in the environmental, lifestyle and genetic makeup of each person. Deviating from the conventional "one-size-fits-all" approach, precision medicine encompasses treatment and prevention strategies for diseases applicable to the average person, and less concerned with differences between individuals (Figure 1).



Precision medicine (PM) is a customized healthcare model with tailor made medical decisions, practices, and/or products specific to the individual patient. It develops appropriate and optimal treatment modalities targeting a patient's genetic content or other molecular/cellular analysis. The new approach for future doctors and scientists will detect, measure and analyze a wide range of biomedical information. These will include molecular, genomic, cellular, clinical, behavioral, physiological, and environmental parameters using modern molecular diagnostics, imaging, and analytics/software.

Considerations of individual variability before treatment and prevention is not a new concept. Blood typing before blood transfusions has existed for more than a hundred years. However, the recent development of large-scale biologic databases such as the human genome sequence and newer methods for characterizing patients using proteomics, genomics and a wide array of cellular assays and computational tools for analyzing voluminous data, has revolutionized medicine. The need of the hour is to create a broad based and creative research programs that permit an evidence based approach in clinical practice.

The precision medicine initiative will have an immediate focus on approaches to the management of cancers and a longer-term goal of generating information applicable to the whole range of health and disease. Taking advantage of social media and mobile devices, PM hopes to motivate the general population as active partners in medical research.

Precision oncology

Cancers are the among the leading causes of death nationally and worldwide. Besides the associated high mortality rates, cancer victims experience very unpleasant symptoms and toxic or disfiguring treatment modalities. Most cancers have their own genomic, tumor-specific signatures. Inherited genetic variations can be responsible for a lifetime of accumulated genomic damage that predispose to the risk of developing cancers. Modern research has thrown light into these oncogenic mechanisms and molecular signatures that have led to a sea change in the approach to risk assessment, diagnostic categories, and therapeutic strategies. Chemotherapy and immunotherapy can counter the influence of specific molecular drivers, leading to newer targeted therapies that have improved outcomes. Some of these have proved very beneficial.

With such deeper understanding of cancers, there has been an improvement in the manner in which the medical community can prevent, diagnose, and treat cancers. As additional tools for molecular diagnosis based on the analysis of many more cancer genomes are made available, newer treatment modalities backed by clinical trials will result in novel strategies and more reliable models for preclinical testing. Development of a larger and simpler digital database to scientists, health care workers, and patients is necessary to understand unexplained drug resistance, genomic heterogeneity of tumors, patient responses to treatment and tumor recurrence.

Tests that detect circulating tumor cells or tumor DNA will result in early detection of cancer or its recurrence. A newer individualized, molecular approach to cancers will impact its prevention, diagnosis, screening methods, and treatments and improve survival rates worldwide.[1,2]

Precision medicine

PM is expected to focus on inherited genetic disorders, infections and environmental related diseases and evolve advanced research strategies that will ensure better assessment of disease risk,

understanding of disease mechanisms, and prediction of the best treatment modalities for many more diseases. The goal of PM is to provide the best benefits to patients globally by heeding all aspects of health and health care.

It is expected that in the years to come, we will see routine blood analysis being replaced by an analysis of the various types of immune cells and usage of mobile devices to provide real-time monitoring of blood glucose and vital signs. Routine genotyping might become a reality to identify genetic variants that confer protection or reflect susceptibility to specific diseases. Furthermore, identification of gut microbes through stool analysis may throw light on causes of irritable bowel syndrome and obesity. Before such innovations are put to practice, longitudinal pilot studies will have to be conducted to collect data through clinical trials, electronic medical records, and other means. These must encompass volunteers from diverse social, racial/ethnic, ancestral, geographic, and economic backgrounds, from all age groups and health statuses. Analysis of biologic specimens including whole-genome sequencing as well as behavioral data by qualified researchers from varied organizations ensuring protection of patient confidentiality is expected to contribute to deeper insights into disease susceptibility, prevention and treatment. This database will also enable observational studies of drugs and devices.[3]

This type of open and responsible data sharing will also enable the volunteers and participants themselves to access their health information and details of applied research. It goes without saying that the creation of such a resource will require in depth planning and execution in order to develop new approaches to disease control and treatment and create strong partnerships between healthcare providers, patient groups, government and private sector. The end result, success or failure must also be examined carefully and audited.

Nations of the world must restructure their regulatory frameworks so that the emerging technology is both safe and effective. The precision medicine initiative will provide early insights into how genes can affect a person's response to particular drugs. This will ensure that the right drug at the right dose to the right patient can both prevent and cure chronic diseases.

The PM approach must be a global collaborative effort tapping the best talent worldwide, involving biologists, healthcare providers, technical staff, statisticians, information technology experts, volunteers and patient groups. Visionary scientists from many disciplines must be involved to ensure that disease control and prevention is successful for a healthy and vibrant living so that everyone has the opportunity to enjoy good health throughout their lifetime.[4]

Advantages of PM

The potential benefits of the PM Initiative are:

a. The creation of newer approaches to protect those participating voluntarily in research, especially with regards to their data confidentiality and privacy.

b. The designing of new methodologies for collecting, analyzing, and sharing large sets of medical data.

c. Innovation of newer, safer and more effective tests, drugs, and other technologies in the health sector.

d. Creation of newer and global partnerships of scientists numerous specialties and also from the community, pharmaceutical industry and premier educational institutions and universities.

e. Extensive voluntary participation and contribution from patients and individuals to advance scientific research to ensure better health worldwide.

f. Better application of a patients' genetic and other molecular information by their treating physicians as a part of their routine medical care.

g. Improved ability to select and apply appropriate treatments for best outcomes.

h. Improved understanding of the etiology and underlying mechanisms of various diseases.

i. Improved strategies to prevent, diagnose, and treat a wide range of diseases worldwide.

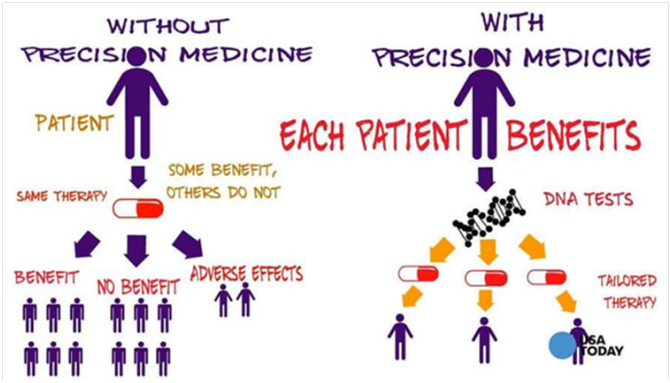
j. Better integration of electronic health records in patient care that will permit doctors and researchers to access medical data more easily.

Drawbacks of PM

The PM initiative is will entail extra expenditure as DNA sequencing and the development of drugs specific for a patient's genetic or molecular characteristics will be expensive. Modes and modalities of contribution or reimbursement from health insurance companies needs to be worked out and will be an issue. Database security may have to be revamped to ensure patient confidentiality.

Conclusion

PM will promote the ability to classify individuals and population groups that differ in their susceptibility to a particular disease and their response to treatment protocols. Preventive or therapeutic interventions can then be concentrated on those who will benefit. This will lower healthcare costs and spare unnecessary medications and their side effects for those who will not benefit. Individuals, families and communities will be empowered by sharing and learning from their health choices and data sharing. Improved research methodology through better and wider data inputs will definitely improve treatment outcomes and disease prevention to ensure health for all. PM will result in customized medications, best applications of medical products or devices, prevent harmful drug interactions and cut costs of healthcare. The discovery of newer and better solutions from inputs of medical data will speed up and personalize the prevention and management of diseases worldwide (Figure 2).



Conflicts of interest

There is no conflict of interest.

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