REVIEW ARTICLE

Precision Medicine in Cancer Treatment: An Update

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Abstract

Precision medicine (PM) is an advanced high-model approach under which standard therapy for the right patient at an accurate time is provided, which is necessary for cancer therapy. Problems such as an individual diversity in gene, lifestyle, environment cause variability of the treatment response, and resistance to medication have been long-term challenges in oncology. Statics show that traditional clinical practices sometimes give poor health outcomes and a misuse of medical resources. In this model, a diagnostic is based on combined therapy using biomarker along with cellular, molecular, and genetic analysis. Diseases such as cancer including lung, breast, colorectal as well as leukemia, and melanomas can be controlled under this effective treatment by a physician to improve the chance of survival, reduce exposure to adverse effect, prevent harmful drug interaction, and increase overall efficacy. This revolutionized technology create a new era of medicine, in which researcher, health providers, and patient work together to improve health, treat diseases, and develop individualized care. Fighting against cancer is common to all countries. The GLOBOCAN statistics data revealed about 14.1 million newly diagnosed cancer patients, 32.6 million people living with cancer, and 8.2 million deaths from cancer worldwide. The cancer PM will hold advanced technology in other field including biotechnologies such as proteomics, next-generation sequencing, bioinformatics, and pharmacology to identify the actual cause for cancer and also tailor-fit personalized therapies.

Key words: Bioinformatics, biomarker, DNA sequencing, molecular analysis, precision medicine

INTRODUCTION

In the current scenario, there are many people, which do not have an effective treatment for the cure and prevention due to lack of proven technology and medicine. However, on January 21, 2015, the US President Barack Obama announced the Precision Medicine Initiative (PMI) in his State of Union address which opens a new field for disease treatment and prevention with investment of $215 million by the National Institutes of Health (NIH), National Cancer Institute, Food and Drug Administration (FDA), and National Coordinator for Health Information Technology. This revolutionized technology creates a new era of medicine, in which researcher, health providers, and patient work together to improve health, treat diseases, and develop individualized care. Statistics shows that traditional clinical practices sometimes give poor health outcomes and a misuse of medical resources. Medical misuse and waste due to ineffective and unnecessary treatment amounted to $75 million per year that is about 30% health-care expenditure in the US. Obama's initiatives of PM choose cancer as one of the immediate targets. China has also stepped forward this approach of PMI and on March 2015 announced their plan and invested about 60 million Renminbi in search for investigation on antibiotics resistance, prediction of

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hereditary diseases in new born, personalized cancer therapy, and preventive measure development.[1,2]

According to NIH, the PM is a medical model that takes into account individual variability in lifestyle, gene, and environment for each person. This emerging advanced approach leads to powerful new discoveries and many new treatments that are tailored to unique characteristics such as individual genetic makeup or the genetic profile of an individual's tumor. Under this, diagnostic testing is based on patient's genetic content, cellular analysis, or molecular analysis. It includes molecular diagnostics, imaging, and software analysis. Diseases such as cancer including lung, breast, colorectal as well as leukemia, and melanomas can be controlled under this effective treatment by a physician to improve the chance of survival, reduce exposure to adverse effect, prevent harmful drug interaction, and increase overall efficacy.[3-5]

PURPOSE OF PM

The main mottos of PM are (1) to expand genomic to develop better prevention and treatment methods; (2) to build a comprehensive scientific knowledge base by developing a wide network of scientific and embarking on a national cohort study; (3) to expand our understanding of diseases as well as health because treatment is based on a genetic understanding of diseases that are most likely to help the patient.[6,7]

CANCER AND ITS TYPES

Cancer represents an uncontrolled growth of cell or gene mutation in a part of the body. As a result, there is the formation of a tumor (benign or malignant) due to uncontrolled cell multiplication, which spreads to other parts of the body.[8] The mechanism of cancer formation is represented in Figure 1.

Cancer may be of various types. Figure 2 shows different types of cancers.

CANCER TREATMENT APPROACHES AND SIDE EFFECTS

In the current scenario, various approaches have been adopted for the treatment of cancer. These approaches have their own advantages and side effects. Commonly employed methods for cancer treatment are given in Figure 3. There are various side effects associated with these treatment approaches which include anemia, bleeding and bruising, appetite loss, delirium, diarrhea, constipation, edema, fatigue, alopecia, infection, neutropenia, nausea, vomiting, memory loss, nerve problem, sexual and fertility problem, urinary and bladder problem, and lymph edema.[9,10]

FIGHTING CANCER WITH PM

Today, when we go for a diagnosis of cancer, we usually receive the identical treatment as others who have same stage and types of cancer. Even though a different person may react differently until the physician does not know why. After decades of research, scientist now recognizes that patient's tumor has a genetic alteration that causes cancer to grow, distribute, and spread. Genomics is one of the main parts of PM treatment [Figure 4]. It permits as to identify the "Achilles heel" of the tumor or genetic driver that induces cancer. Biotechnology in the field of PM including proteomics, next-generation sequencing, bioinformatics along with pharmacology is used to identify the actual cause of cancer as well as tailor-fit personalized therapies.[11,12]

Using biomarker test and the antibody therapy in combination has an actual effect in an individual treatment. A biomarker is a biological molecule found in tissue blood and body fluid. By identifying correct biomarker physician and researcher

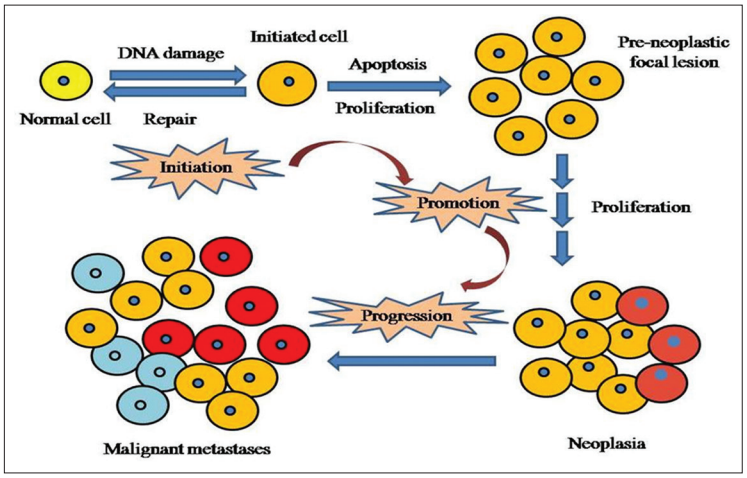

Figure 1: Steps involved in formation of cancer

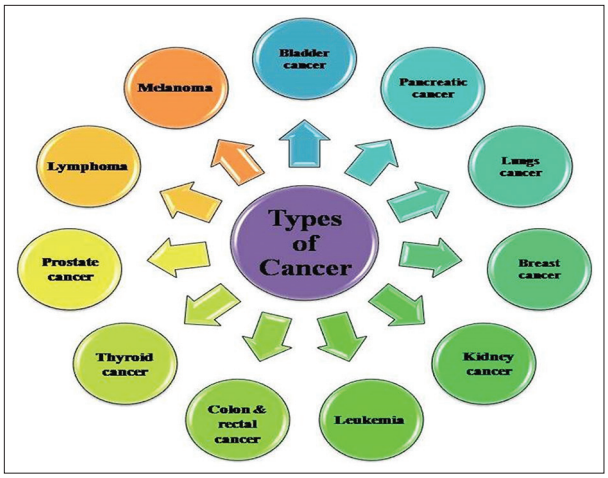

Figure 2: Common types of cancer

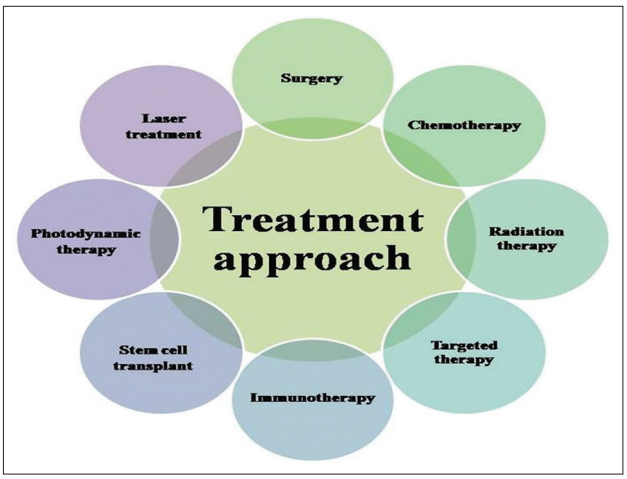

Figure 3: Cancer treatment approaches

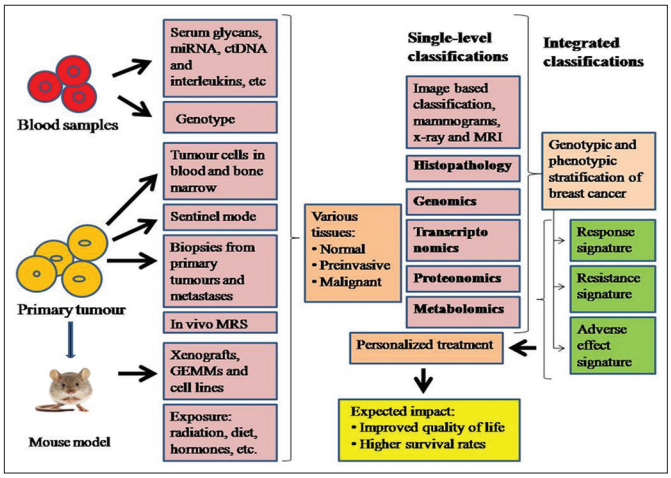

Figure 4: Precision medicine: System biology of cancer

can easily determine as well as track their actual presence and absence as a measure of how well the body shows responds to a treatment. Biomarker not only helps to indicate drug toxicity, drug efficacy, and resistance but also use in pharmacodynamic-based therapeutic drug monitoring as the non-surrogate and surrogate endpoint. In this way, various challenges that pre-occupied doctors for a long time can be easily overcome with the help of PM. Earlier selected drug is used to treat the patient. In the future, biomarkers will become an important element that reveals more specific information and also able to eliminate the uncertainty of treatment. For example, a simple blood-based test is expected to replace tumor tissue samples in RAS biomarker testing. They may also be used in next-generation sequencing, multianalytic diagnostic panels, and whole exon sequencing.[13-15]

POTENTIAL BENEFITS OF PM

The genomic sequencing is most often recommended for opting the PM to the pediatric and adult patients who have active cancer, failed standard treatment, and a high risk of relapse or progress. The PM shows various long-term and other benefits,[16,17] which are as follows:

Long-term benefits

- Expand the ability of the physician to use patient's genetic and molecular information as part of regular medical care.
- Identity, an effective treatment which will work best for specific patients.
- Improved ability to predict the best possible treatment.
- A better understanding of the mechanism by which various diseases occur.
- Improved methods for preventing, diagnosing, and treating a wide range of diseases as well as rare diseases.
- Better integration of electronic health record in patient care to access medical data more easily.

Other potential benefits

- A new approach for supporting and protecting particularly privacy research participants and the confidentiality of their data.
- Providing an opportunity for a million people to contribute to the advancement of scientific research.
- Create and design new tools for analyzing building and having huge sets of medical data.
- It held to ensure that the products are safe and effective through improving FDA over the sight of the test, drug and other technologies to support innovation.

SHORT COMINGS OF PM

Even though PM creates an effective and supportive role in the field of DNA sequencing technology, but some PM associated shortcomings,[18,19] which raise ethical, social, and legal issues are as follows:

- PMI itself will cost many millions of dollars.
- Technologies such as DNA sequencing, a large amount of DNA is required, which is still too costly to carry out.

- Drugs that are developed to target a person's genetic or molecular characteristics are likely too expensive.
- Investment from third party payer such as private insurance companies for targeted drugs is also likely to become an issue.
- Doctors and other health-care providers will need to know more about molecular genetics, cellular genetic, and biochemistry.

CONCLUSION AND FUTURE PERSPECTIVES

PM aims at standard therapy for the right patient at the right time which is essential for cancer treatment. The cancer PM incorporates advanced technology to identify the actual cause of cancer and also tailor-fit personalized therapies. Beyond the success in clinical and research practice, the PMI also motivates partnership management between the health-care providers and the academia. Implementation will also strengthen collaboration with the commercial and industrial sector including medical device manufacturers and pharmaceutical companies that supply indispensable product, distribution, and service. Lateral economic development, medical progress, is complimentary. Hence, the approach of PM collectively coheres and supports various social sectors on the way to success. In future, this PMI will become part of other medical treatment and broader application on other diseases including obesity and diabetes, hence, rapidly becoming a spotlight throughout the world.

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