# Personalized Medicine – A Valuable Tool in Healthcare Management

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## ABSTRACT

Personalized medicine (PM) is the future of an uncompromised medical care of individuals by shaping their treatment as per their individualistic genetics, epigenomics, and clinical information which gives an transparent insight of his/her unique genomic profile. Further, this is customized in such a way that it would be able to predict and portray the future vulnerability of an individual's disease, hence giving preventive all round therapy.

PM approach is an extension and a step ahead of traditional pharmaceutical approach (i.e., One-For-All). This increase the predictability of medical treatment based on the unique genetic information of the patient, which will be safer and more effective.

PMs are the treatments based on the genomic profile of the patients that can influence the response to drug. In major therapeutic areas they have a sure shot biomarker and several 'omics' technologies to target the drug discovery efforts at the responsive therapeutic areas. The PM is a driver of the integration of various biotechnologies, such as RNA interference and nano-biotechnology which are being used in drug discovery. A new era of PM may be considered by mean of "right therapy" for "right patient" at "right time" in its "most effective form".

PM is one of the youngest strategy emerging beautifully in the field of healthcare management in which a physician can select a therapy on the basis of genetic profile thus minimizing harmful side effects with the guarantee of more successful outcomes. Moreover, this will be a cost effective practice in comparison to the ongoing 'trial-and-error' approach to manage diseases.

**Keywords:** Pharmacy, Drugs, Patient compliance, Precision medicine.

## INTRODUCTION

Personalized medicines (PM) are defined as the "customization of medical treatment to an individual genetic profile" or it can also be defined as the safest and most effective delivery of drugs to individual [1]. Over the past few decades, there has been increasing accent on medicine's optimization and developing personalized medicines to deliver better patient care. It is a medical concept/model, with all decision and practices being transcribed to the individual patient by use genetic information that proposed customization of health care. Example of PM includes using targeted therapies to treat cancer cells, i.e. HER-2 positive breast cancer cells [5, 6]. The ultimate goal of PM is to target molecular measurements by validation and ultimately the patient population is in need of ameliorate diagnostic precision [4]. It eliminates trial and error approach precisely from our conventional clinical practices, bringing out a much-optimized view in the era of medical treatment.

The PM has suggest that significant changes in medicines/therapy from a model of "one size fits all" to an approach that customize the predictions, diagnosis and treatment with perfection for an individual patient [5-7]. PM should have been understood as a "rhetorical entity" employed by academics and clinics in regulations, patient advocacy and clinical practices not only to define a future state but bring it into being. The clinicians have also been using the term personalized medicines for a patient centered care in which they comprehend and respond to patient perspectives and practices the 'art' of clinical judgment . The outline of the process of PM is depicted (figure no. 1)

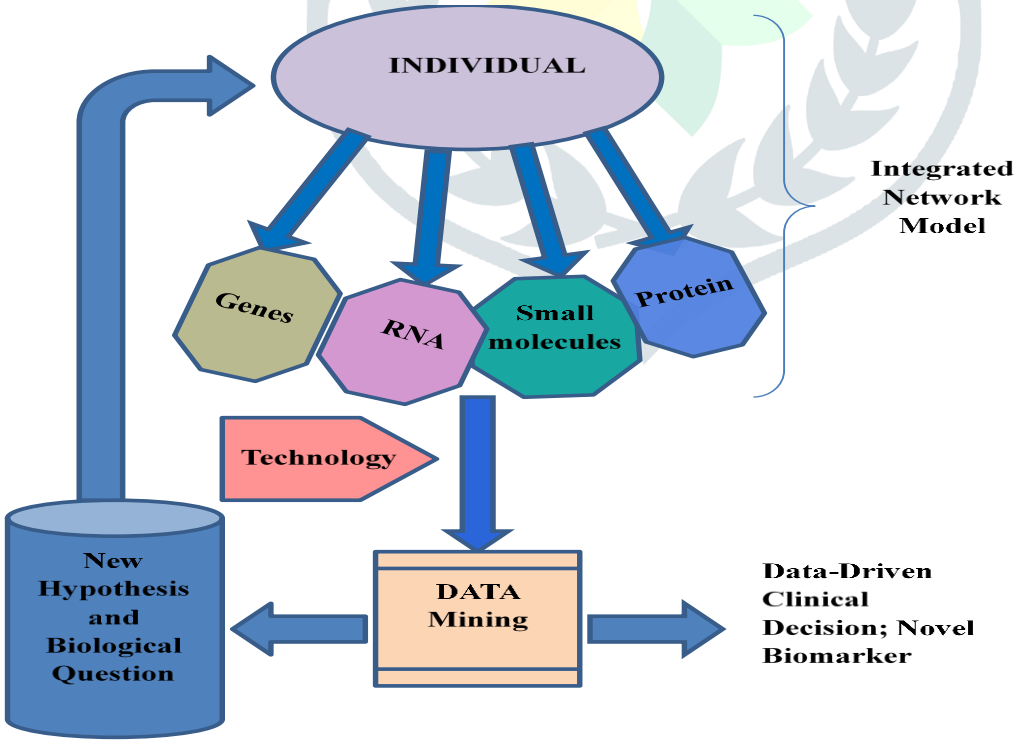



**Figure 1:** Personalized medicines process

### History

Over the past few decades, the drug response is generally considered with reference to various factors including

patient's age, health, nutrition, environmental exposure, epigenetic factors and concurrent therapy. Personalized medicines had first appeared as published work in 1999, however some of the field's core concept has been in existence since the early 1960 [8-10]. The progression and emergence in new technologies have enabled the researchers to establish link between drug molecule and its clinical profiles, thus making personalized medicine a more practicable.

By the 20th centuries, clinicians had developed a kind of personalized approach to treat patients. High variability in drug responses was observed earlier in 1950 that led to the emergence of a new scientific discipline known as pharmacogenomics, which deals with deep understanding of drug response [3]. Pharmacogenomics involves the convergence of other disciplines viz. genetics, biochemistry, molecular medicine and pharmacology.

**Key Elements**

PM is most commonly designed on the basis of individual genes and biomarkers that help to predict, decide, diagnose and prevent the diseased condition by growing a inherent for concurrent evaluation of multiple genes (genomics) [8, 16].

However, the perspective of the term "personalized" is focused exclusively on the human genome that targets on prevention of a disease rather than treating it after getting it worse. In addition, spare interest to genetic danger should have the un-intended impact of minimizing different predictors of health or the role of affected person values and choice to fitness care (figure no. 2). Understanding PM as a complete attempt to tailors health care to the individual, spanning multiple dimensions, more accurately reflects clinical reality [1].

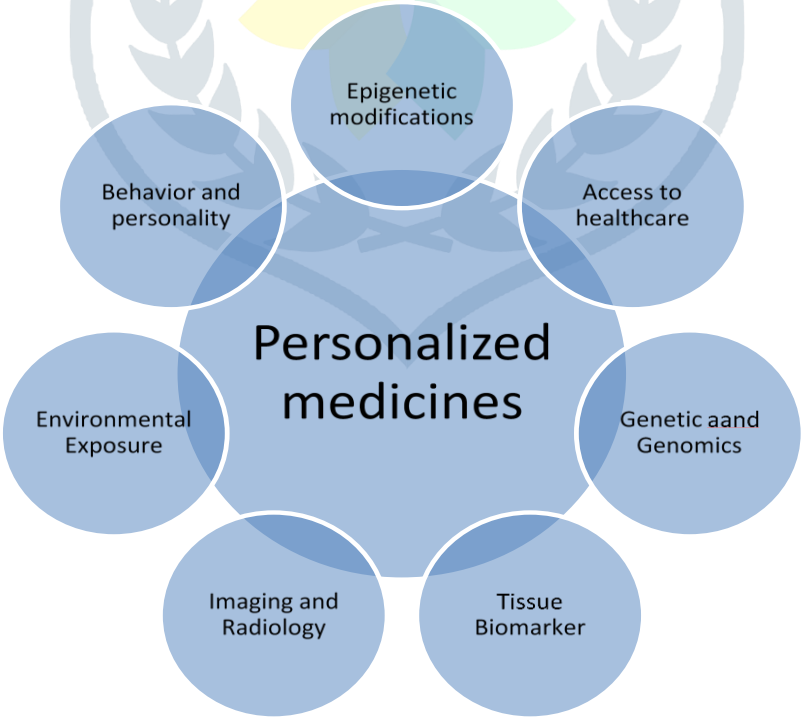



**Figure 2:** Elements of personalized medicines

**Context of Genomics**

Pharmaco-genomics, the genetic testing has use to direct the drug treatment, demonstrates merits, demerits and the impediments of a genome-centric vision of PM. A recent examples of genetic testing is abacavir. About 5-8% people of European descents, 2-5% of American, and 2-7% Hispanics have a histo-compatibility gene variant, HLA-B*5701, that confers a risk exposed to abacavir. Because of the hypersensitivity in reaction, now experts are advising for genetic testing before prescribing a drug.

The antiviral drug (abacavir) well known pharmacogenomics addresses only a narrow spectrum of care. Affected persons with HIV infection with other treatment and legal decisions, personal, social and moral issue arises for the patients. PM, in this feel, comprise with adapting the full range of medical tools and professional skills to fulfil the specific desires of the individual pursuing care.

Delivering of this type of personalized care is difficult task, even setting apart the clinical uncertainties, screening and treatment. Discussions of PSA (Prostate-specific-Antigen) testing must be prioritized towards the affected person's health concerns.

all the benefits of customized medicines in health care relies significantly on the predictive value of the genomic profile: with bad predictive value, genomic risk assessment could result in an unacceptable rate or a higher price of adverse screening events.

A better aspect of understanding of biomarkers or target molecules for prostate cancer will work within the direction of new drug development. Which indeed some other potential benefit from genomic. that will require a long-time period research investment. The improvement of recent drug on the basis of genomics or other molecular techniques that would hit to specific target characteristics [1]. It is used by clinicians for improving individual care.

**Context of Personalized medicines**

Genetics offers a better optimized paradigm treatment as it inculcates dynamic view for benefitting an individual by incorporating newer tests and technologies which are proven as a effective tools. There are many endangerments associated with PM in relation genomics. The clinicians/patients and other elements of individual care might be less important [1].

Considering genomic risk profile, pharmaco-genomics test and genome centered diagnostics are now established to give an optimized assistance to all the patients.

Two cautions remain, like any promising technology, new genomic test need to be assessed for their effectiveness [1]. Moreover, if health support is absent, the benefits of genomic tool will be considered. The benefits are derived from research that would serve the need of PM in a larger context of heath and disease prevention.

**Advantages of personalized medicines**

A) Efficiency of care:

PM make decisions supremely based on the individualistic factors that are specific for their health. Today decision making regarding treatment is based on the patients, as even doctor doesn't know any better

treatment might be affect particularly individuals and their condition. With PM in use, a practitioner can provide a customized treatment for each patient, improving their health care.

B) Preventive care:

When the genetic screening process collect enough samples, then the results are generated based on the understanding of the genetic risk of patient and the diagnosis will be based genetically rather than simply reacting to an illness [7, 8]. The study of specific genes responsible for causing a disease with the help of biomarkers result in greater preventive care for an individual.

C) Limit cost:

PM is cost effective because there are based on targeted treatment. The cost can be lower when it focuses on the preventive care rather the treatment of a disease by conventional hit and try method without exactly knowing the responsible genes, which eventually not only increase the time consumed but also affects the patient financially.

D) Population health:

The study of the genetic pattern in a population as a whole, and to make sections that can help in identifying the cause and also develop the treatment for individual patient. The study of the genetic sections of a population can predict the disease and then its early prevention can be done.

**Intervention of PM will leads to following most significant benefits**:

1) Earlier disease intervention with specificity and concreteness.
2) Better disease analysis and hence proper prevention of disease.
3) More informed medical decision could be made.
4) The probability of negative side effect would be reduced to a large extent that works for the betterment of patient's overall health.

Benefits of PM have also been listed in table no. 1.

**Table 1:** Benefits of PM w.r.t. Industry, Patient and Clinicians

| Advantage of personalized medicines into pharmaceutical industry: | Advantage of personalized medicines for patient and clinicians: |
|---|---|
| • Increased efficiency and reduced costs of target and lead discovery<br>• Reduced timelines and costs of clinical trials<br>• Emergence of new gene targets for drug discovery<br>• Product differentiation in the market place | • Higher probability of desired outcome with a drug<br>• Low probability of untoward side effects<br>• Preventive strategies<br>• Focused therapies<br>• Reduced costs<br>• Better health and better healthcare |

**Drawbacks of personalized medicines:**

A) Infrastructure requirement:

PM have flexible potential in healthcare sectors, however for that, it requires monolithic infrastructure and more time to implement it perfectly. For implementation of the PM, the fundamental modifications within the infrastructure and also mechanism of data collection, storage and sharing are needed to be framed in any such manner that affected person's privacy and transparency is maintained. The requirements for making the PM will now not be covered by the federal funds however the question is who is ultimately liable for spending the fund (state or central government, patients).

B) Legal problems:

PM plenty of genomic information need to be collected from a substantial number of human beings while representing each segmentation. when this genomic information has been accumulated it is illegally uncertain to personal the information. The authorities does not own the information, FDA blocks the genomic statistics from companies. The hassle in this is whoever owns the information that they could be accountable for that and it may be actually expensive keep those statistics documents adequately.

C) Healthcare cost:

Ideally personalized medicines can eliminate the repeated efforts, helps to take preventive measures against diseases, hence stopping the fund in healthcare. For collecting, storing and sharing information and other add on expenses requires lot of investment which could prove to be a burden.

**Examples of personalized medicines**

There are many great examples based on genetic profiles. Before explaining the classical examples, I must emphasize that PM can be used for treatment of diseases, but also used for prevention and detection of diseases. There are some of examples of drugs of PM used for particular diseases as shown in table no. 2.

**Table 2**: Drugs used in personalized medicines for variable diseases

| S. No. | Drug | Disease | Year | Reference |
|---|---|---|---|---|
| **1.** | Inunitib | Chronic myeloid leukemia | 2018 | Dancik & Theodorescu, 2018 |
| **2.** | Leucovorin | Colorectal cancer | 2017 | Aziz, Yousef, Saleh, Mohammad, & Al Knawy, 2017 |
| **3.** | Teplizumab | Diabetes (Type 1) | 2016 | Anaya et al., 2016 |
| **4.** | Teplizumab | Diabetes (Type1) | 2016 | Anaya et al., 2016 |
| **5.** | Tarceva | Lung cancer | 2015 | Kukk, Moors, & Hekkert, 2015 |
| **6.** | Adriamycin | Bladder cancer, kaposi's sarcoma | 2015 | Jain, 2005 |
| **7.** | Fluoxetinec | Antidepression | 2014 | Alomari, Mohamed, Basit, & Gaisford, 2015 |
| **8.** | Abacavir | AIDS | 2013 | Wylie burke et al. |
| **9.** | Herceptin | Breast cancer | 2011 | Crommelin, Storm, & Luijten, 2011 |
| **10.** | Rituximab | Non-hodgkin's lymphoma, chronic lumphocytic leukemia | 2010 | Isaacs & Ferraccioli, 2011 |

**PRIMAQUINE:** The primary classical instance of drug is PQ (Primaquine). PQ has been prescribed in malaria, where the malaria endemic. but military physician observing in the past that some of the soldiers that were using this drug had become anemic and ultimately confirmed the signs and symptoms i.e. acute hemolytic anemia (AHA). It was later proven that the individuals exhibiting AHA after PQ administration carried variants in G6PD. current clinical practice for PQ therefore call for genotyping of sufferers to peer if they carry relevant variants in G6PD that could discourage PQ use for them [11].

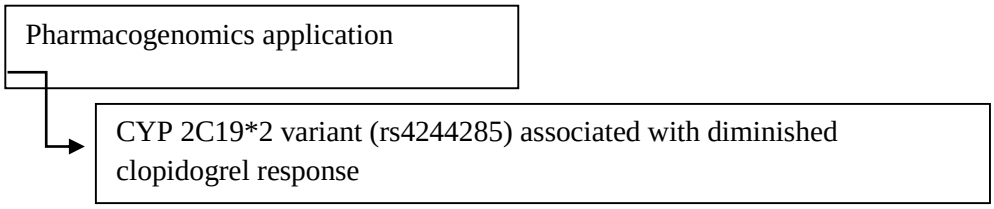
**IMATINIB:** Another instance of drug is Imatinib. it is used for CML (chronic myelogenous leukemia). It inhibits the enzyme, tyrosine kinase, that is elevated by the formation of fusion of genomic regions, one encompassing the Abelson proto-oncogene (abl) and other is breakpoint cluster region (bcr). This fusion arises in many tumors contributing the development of CML and is known as bcr-abl fusion. however, no longer all individual with CML have tumor harboring the bcr-abl fusion. consequently, imatinib is commonly given to CML sufferers with this fusion event [11].

**TEMOZOLAMIDE (TMZ):** is another example of PM, it is effective in 20% concentration to treat gliomas who carry methylated (inactivated) DNA repair enzymes. A simple polymerase chain reaction can determined whether a patients stands to benefits for TMZ treatment [5].

PM also includes presymptomatic risk assessment, prognosis, diagnosis, remedy and pharmacogenomics and pharmacogenomics applications for genetic testing as shown in table no. 3.

**Table 3:**Different levels of genetic testing in personalized medicines

| | |
|---|---|
| Pre-symptomatic risk assessment | BRCA1/2 testing for breast cancer<br>Lynch syndrome testing for hereditary colon cancer<br>Long QT interval Spinal Muscular Atrophye |
| Diagnosis | Beta thalassemia - Fusion genes and rearrangements including BCR-ABL, E2A-PBX1, TEL-AML1, and MLL in pediatric leukemia<br>Gene expression profiles define subtypes of breast cancer<br>Human Papilloma Virus detection<br>Hepatitis C detection<br>PCR detection of micro-organisms (bacteria, fungi) |
| Prognosis | Fragile X syndrome (number of trinucleotide repeats predicts severity)<br>Gene expression signatures and prognosis in breast cancer<br>Gene expression analysis and lymphoma prognosis |
| Treatment and pharmacogenomics | Therapies for targeted gene mutations in cancer<br>EGFR point mutations in lung cancer and glioblastoma and cetuximab, gefitinib, erlotinib, panitumumab, lapatinib treatment<br>KIT, PDGFR mutations in sarcoma, glioma, liver and renal cancer, melanoma and imatinib, nilotinib, sunitinib, sorafenib treatment<br>BRAF mutations in melanoma treated by RAF inhibitors<br>BCR-ABL translocation in chronic myelogenous leukemia treated by imatinib<br>KRAS wild-type status correlated with resistance to EGFR inhibition<br>PARP inhibitors in BRCA mutant breast, ovarian, prostate and pancreatic cancer<br>Herceptin (Trastuzumab) in HER2 + breast cancer |




The PM not only used in treatment but also used in drug therapies i.e. Mutation specific remedy, personalizing early detection approaches and personalizing disease impediment.

- **Mutation-specific therapies:-**

The drug Ivacaftor was designed to heal cystic fibrosis (CF) that has pathogenic mutation in the gene 'CFTR'. The CFTR have variety of functions, but it is dictated to 'gate like' structure that can be open and close to control the movement of salt in and out of cells (Goetz & Schork, 2018). In the presence of mutation it could open the gate for longer period of time rather than close the gate.

- **Personalizing disease prevention:-**

In the scientific community the development of personalized disease prevention strategies by the use of genetic information, but this were not acceptable in clinical practice. The example is that relates to the colorectal cancer. In 2015, the use of aspirin has reported varying effect on risk of development of colorectal cancer that depends upon the individual's genotype.

**Future perspectives of personalized medicines**

The human genome project is a great foundation for PM. It has ability to customize the remedies to individual patients via incorporation of genetics with molecular profiles. Ginsburg and McCarthy states that personalized medicines intersect with the course of a patient's diseases at six major points, i.e., predisposition, prognosis, screening, diagnosis, pharmacogenomics and monitoring [10].

Further, personalized medicines can be used as great screening tools through which we can identify the protein marker responsible for the diseases and thus have an early access for an earlier treatment with less mortality and morbidity.

Advances within PM will also increase the efficiency and pharmaceutical development as drug developer can now use toxigenomic biomarker to screen the compound and improve selection of patients for clinical trials to reduce the number of unintended failures (Table 3).

**Conclusion**

Currently the approach of "one size fit to all" or "universal" is being practiced by all healthcare professionals. However, based on state of patient as well as the disease, the customization of drug therapy has to be done individually and this is a huge step in the healthcare field to provide a collaborative all round care.

One of the major reason for the failure of various treatment may be universal approach. The PM can be a good tool to take care major therapeutic areas like cancer, AIDS, diabetes, etc. The implementation of PM may be costly interlay but, if therapy goes well the overall cost (including tangible as well as intangible) will be reduced

significantly. Further, it provides the patient with better quality of life. These attributes and benefits, hopefully impel all the stakeholders for adapting PM toward faster and more efficient healthcare system.

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