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# Role of Precision Medicine in Cancer Therapy

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## ABSTRACT

Cancer, which is also called malignancy, is an abnormal growth of cells. There are more than 200 types of cancers including skin cancer, lung cancer, breast cancer, colon cancer, prostate cancer, lymphoma etc....Cancer treatments are varying like chemotherapy, radiation therapy, surgery etc... but these can be effective only in a subset of the population. Thus, the inherent variability of cancer has led itself to the growing field of precision medicine. Precision medicine plays a major role in cancer therapy. Precision medicine involves the usage of genetic changes in a patient's tumor to determine the type of treatment one has to undergo. Precision medicine is an approach to patient care that allows doctors to select treatments that help patients based on a genetic understanding of their disease. This review highlighted the importance and role of precision medicine in cancer therapy.

**Key Words:** Cancer, Precision medicine, Chemotherapy, Genetic changes, Chemotherapy

## INTRODUCTION

Cancer is a devastating disease when treatment like chemotherapy and radiation are effective only in a subset of the population.<sup>1</sup> The inherent variability of cancer has lent itself to the growing field of precision and personalised medicine.<sup>2</sup> Precision medicine involves testing DNA from a patient's tumour to identify the mutation or other Genetic changes that drive their cancer. They are targeted on patients whose tumours or a specific gene mutation. These are blocked by certain drug compounds.<sup>3</sup> Ten years ago, researchers in Dana Farber Cancer Institute published that in non-small cell lung cancer patients, tumours had a mutated version of a protein. The epidermal growth factor receptor EGFR responded to a drug that specifically targets the EGFR protein.<sup>4</sup> Patients with HER2 positive breast cancer survivors for 2 to 3 years who received the targeted therapy with the drug trastuzumab which is also known as Herceptin.<sup>4</sup> Technologies supporting precision medicines CRISPR/ cas Technology (gene editing), cryo-electron microscopy (cryoEM) in which the samples are examined at extremely low temperature After decades of research, scientists understand that patients' tumors have genetic changes that cause cancer cells to grow and spread to various organs.

As deeper understanding of tumor and rapid advances in technology is taking place, there are enormous opportunities to create a future for precision medicine in oncology which can be highly specific with minimal toxic effect on patients. Development of precision medicine for cancer patients improves their quality of life. It creates a wider ability of the doctors to use the patient's genetic and other molecular information. Precision medicine helps in avoidance of unnecessary treatment, has lesser side effects or trauma, extended survival rate and reduction in total cost of treatment.<sup>5</sup>

## CANCER AND ITS TYPES

Cancer is an abnormal growth of cells which can arise from any organ or body structure which causes tumour, lesion or lump. Risk of cancer is multiplied in those whose immune system is suppressed due to factors like chronic stress, old age, chronic debilitating disease, previous use of chemotherapy, abuse of drugs such as analgesics, Antibiotics and corticosteroids.<sup>6</sup> There are various types of cancer like colon cancer, breast cancer, prostate cancer, lung cancer, pancreatic cancer, skin cancer and cervical cancer.<sup>7</sup> In women the highest cancer prevalence is breast cancer, lung cancer,

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pancreatic cancer, bronchus, colon and rectum cancer, uterine corpus and thyroid. In children, the highest prevalence is blood cancer, cancers related to brain and lymph nodes.<sup>8</sup> Many pharmaceutical studies have been on various cancers like oral cancer, hepatic cancer, oral epidermal cancers etc... Several types of cancer can form in the liver. The most common type of liver cancer is hepatocellular carcinoma. There are other types of liver cancers like intrahepatic cholangiocarcinoma and hepatoblastoma which are less common. Oral cancer is one of the common cancers. Generally, the defective apoptosis (programmed cell death) results in enhanced growth in most of the cancer.

## TREATMENTS OF CANCER

There are several treatments for cancer like surgical removal, chemotherapy or other types of cancer specific medication, hormonal therapy and radiation therapy some cancer cells shrink and disappear on their own like in kidney cancer, targeted therapy and radiotherapy. Other treatments include nano medicine, extracellular vesicles for cancer diagnosis and therapy, natural antioxidants in cancer therapy, targeted therapy and immunotherapy, gene therapy for cancer treatment, thermal ablation and magnetic hyperthermia, recent innovations like radiomics and pathomics.<sup>9-13</sup> Natural medicines which are rich sources of antioxidants. Antioxidants have the potential to suppress cancer and reduce the risk of cancer. Vitamin A, C, E has been reported to reduce the risk of lung cancer.<sup>14</sup> Sometimes proteolytic enzymes are also used in the medical field especially in cancer therapy.<sup>15</sup> Recently nanomedicine has gained a crucial role in cancer treatment.<sup>16</sup> Some studies have shown that photosynthesized gold nanoparticles induce apoptosis in cervical cancer cells.<sup>17</sup> Another study proved that Sesame induces apoptosis in thyroid cancer cells.<sup>18</sup> Nanoparticles from *Marsdenia tenacissima* induce apoptosis in laryngeal cancer.<sup>19</sup> Thus nanomedicine, precision medicine, gene therapy etc. are the upcoming treatments in cancer showing better cure.

### Failure of treatment

Failure of treatment can be due to varying reasons like unavailability of effective biomarkers, sometimes cancer diagnosis and prognosis becomes difficult. Limitations include conventional chemotherapeutic agents. Metastasis and angiogenesis are a huge problem. Targeting cancer stem cells is difficult. Unresolved inflammation facilitates immune evasion. Growth promotion of cells causes induction of neoplasia where precancerous polyp formation occurs.<sup>20</sup> Radiation and chemotherapy are the standard treatment for cancer which works by attacking stem cells rapidly in our body. They do not differentiate between healthy cells and cancerous cells. Thus, these treatments cause adverse side effects and often lead to failure in treating cancer.

## Precision medicine

Due to the unpredictable nature of cancer and failure possibilities of other treatments, precision medicine can play a major role in cancer.<sup>21</sup> The two major roles of precision medicine are deep genome and transcriptome sequencing which helps in facilitating the discovery of molecular players which are involved in cancer onset to identify more reliable biomarkers. Advances in the development of genetic tests has created a potential to transform and create the ability to detect, prevent and treat certain diseases. Therapy approaches which are based on genetic variants and specific biomarkers have been increasing over the last few decades in association with the increasing availability and affordability of genomic sequencing technology. There has been growing interest in and advocacy for precision medicine approaches.<sup>22</sup>

### Precision medicine versus personalized medicine:

According to the National research Council, 'personalise medicine' is an older term but it means similar to Precision medicine. But the concern is that the word personalised is misinterpreted to imply the treatment and prevention.<sup>23</sup> Precision medicine is developed uniquely for each individual and focuses on identifying which approach is effective on patients based on genetic and environmental factors.<sup>24</sup> The best example for personalised medicine is CYP 450 enzyme and its application to Coumadin therapy (medication used as anticoagulant to treat blood clots). A common example for precision medicine is gleevec drug which is used to treat leukaemia only when the cancer cells have a particular type of genetic makeup.

### Advantages of precision medicine

Precision medicine avoids the unnecessary treatment, side-effects, trauma, has an extended survival rate and wider adoption.<sup>25</sup> It involves collecting patients genetic and molecular information for routine medical care. It has an improved ability to predict which treatment is best for a specific patient. It has a better understanding and underlying mechanism for various diseases. Precision medicine has an improved approach for preventing, diagnosing, and treating a wide range of diseases. For better integration, electronic health records are being used to access the medical data easily.<sup>26</sup>

### Precision medicine in cancer therapy

Each individual has their own unique genome, which may include small single nucleotide polymorphisms (SNPs) and/or large changes in DNA nucleotide sequence (mutations). These may take over but also can initiate during a person's lifetime through external agents (e.g. carcinogenic chemicals or radiation). It is usually harmless to the well-being of the individual, these genetic modifications can affect the way the body responds to a therapeutic agent either

through differences to the drug target, or through ADMET considerations (i.e. absorption, distribution, metabolism, excretion and toxicology).

Precision medicine, sometimes referred to as ‘personalized medicine’ and abbreviated to ‘PM’, could be a term that’s increasingly being employed to explain treatments, including therapeutic agents, tailored to individual patients or groups of patients. The goal is to match therapies to individuals to confirm that they receive effective treatment with minimal toxicity. This is often particularly important for cancer patients who may have a limited lifetime. It is a more individualised procedure based on genetic changes in a person’s cancer. There is no need of undergoing repeated cycles of chemotherapy and radiation therapy. There are several drugs which have been approved by the Food and drug administration in the US where the drugs target genetic changes like cells, based on type and the region of spread of cancer.<sup>27</sup>

### Precision medicine in breast cancer

Breast cancer is one of the leading cancers in women. The factors of breast cancer can be genetic, environmental, behavioural like diet, exercise and lifestyle. Increasing evidence of personal genomics susceptibility is the major factor of intervention and prevention.<sup>25</sup> The predominant breast cancer is associated with expression of oestrogen receptor which is used as a predictive marker.<sup>22</sup> Two main types of breast cancers are the inter tumour heterogeneity where the cancer arises from the site of same origin and the other type is spatial and temporal intra tumour heterogeneity. In this, there is a reflecting increase of variability in gene mutation in a single tumour.<sup>29,30</sup>

### Precision medicine in colon cancer

Genetics and epigenetics in colon cancer is characterised by colonoscopy screening which detects the mutation and microsatellite instability, hyper methylation in tumours in response to treatment.<sup>25</sup> Patients with stage one CRC receive colonoscopic polypectomy, endoscopic mucosal resection and for more advanced stages, surgical resection is done.<sup>30</sup> Among the certain types of cancers, solid tumors with inter-patient heterogeneity witness a paradigm shift in the management plan using precision medicine which is more likely to happen. Colorectal cancer (CRC) which is very heterogeneous could be a model disease to execute the concept of precision medicine.

### Precision medicine in lung cancer

There are two main types of lung cancer - non-small cell lung cancer and small cell lung cancer non-small cell lung cancer. Small cell lung cancer occurs in 20% of the patients. A drug called Crizotinib which is an inhibitor for anaplastic lymphoma kinase shows promising results. Another drug called erlotinib also shows significant results. Non-small cell

lung cancer depends on pathological findings. Targeted therapy is based on molecular profiling and tissue preservation.<sup>31</sup>

## DISCUSSION

Cancer is an uncontrolled growth of abnormal cells. Glioma is the primary cause of cancer in most of the people.<sup>32</sup> There are about 200 types of cancer. Cancer symptoms are different in different cancers. They can be fatigue, weight loss, pain, skin changes like photoaging change in bowel, unusual bleeding, persistent cough, fever and lumps. Research shows that excess body fat increases the risk for several cancers like colorectal cancer, pancreatic cancer etc. Consumption of high dietary fat results in increased fat and storage and can lead to metabolic disorders like stroke, diabetes etc.<sup>33</sup> There are certain cancers which can be specific for a particular gender or age group. Many studies and researchers have been widely done on this. Usually, treatment of cancer or chemotherapy, radiation therapy and surgery. But new technologies are making a difference in fighting against cancer. Precision medicine is the future hope of the growing field as it involves the testing of DNA to identify the mutation in a patient’s tumour. Adaptation to precision and personalised medicine in cancer can bring a great change and can increase the survival rate in many cases.

## CONCLUSION

Research has moved beyond sequencing and it has accurately linked the information of individual patients to receive better outcomes. Treatment responses to precision medicine are highly positive and have an increased survival rate. It helps patients based on the genetic understanding of the disease. The future use of precision medicine can be a better and efficient way to treat cancer and other deadly diseases.

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