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The Role of Informatics in Cancer Personalized Medicine

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Abstract

No doubt, significant number of people have been suffering from an adverse effects of medications especially that of traditional or self-medication to the extent that deaths occur. These effects happen as a result of mismatches of biological makeup of individuals taking these kinds of medications. This paper presents the state of the art of Personalized Medicine and Informatics in treatment of Cancer as well as some challenges the Informatics faces in Personalized Medicine in Cancer.

Introduction

Many people have been suffering and dying as a result of adverse effects of medications that mismatch with their biological makeup within their bodies. Research has shown that, in every year, over 106, 000 people in the United States alone die due to adverse reactions of correctly prescribed doses of drug; while about 2.2 million are recorded in a serious suffering of these effects [1]. Considering the mortality rate made mentioned above, what could happen to the developing world in regards to negative reactions of medication? Indeed, large amount of population is victimized.

In order to avert and overcome the ramification of medication due to genetic variation of patients, some new state of the art methods and technology should be employed in our healthcare system. Personalized medicine is becoming more and more popular and acceptable current landscape of the healthcare, considered as an extension of traditional techniques of health services for wider and efficient understanding, diagnosis and treatment of disease. Because of its success it is regarded as the "right treatment for the right person at the right time" [2]. And this really alleviates negative drug's reaction.

The main aim of personalized medicine is to make good use of information related to individual genomic profile and characteristics to come up with an efficient and preventive approach in prescribing doses of drug as contrary to "one size fits all" model [3]. Despite its success, personalized medicine faces lots of informatics

challenges in trying to integrate with databases and find the desired genomic information for the improvement of the healthcare services across the globe.

1.0. Background

Personalized medicine is a modern skill in healthcare programmes aimed at using genomic profiles of individuals to study their genomic characteristics so that right medications and prescriptions are given to the right patients at the right time. The motive is to minimize and put in control the rate at which people in different part of the globe get affected and some even lose their lives due to the side effects or adverse reaction of medication. The reason for this problem is connected to the fact that people react differently to the same drugs especially drugs like painkillers, antidepressants, and some medicines for the treatment of blood pressure and asthma as a result of differences in their genetic makeup [2,3]. It is obvious that, "one size fits all" way of treatment has been the wider approach all over the world where diagnosis to patients suffering from particular diseases is based on the observable symptoms and some evidences from laboratory examination. In this method, cohorts of patients that exhibit the same symptoms are given the same treatment. This method seems to be trial and error because majority of patients are prostrated, keep on going back to hospitals with the same previous complain about particular disease. They spend a lot of money and time, always changing medicine that the physician thinks it would be better than the one previously prescribed. For this reason, cases of over dose, drug addiction and withdrawal of treatments are very common in societies. Research has statistically shown that lots of drugs for the treatment of sensitive diseases like cancer, asthma, heart diseases, diabetes etc. are ineffective to many patients and harmful to some. On average bases as it can be seen in fig 1 below, only 50% of drugs taken by patients work effectively [3]. It is therefore essential to have an individualized medicine which in this case referred to personalized medicine where a profile of a patient's genetic variation is used to guide physicians in proper selection of drugs or treatment protocols that will help overcome the problems associated with traditional approaches of medication.

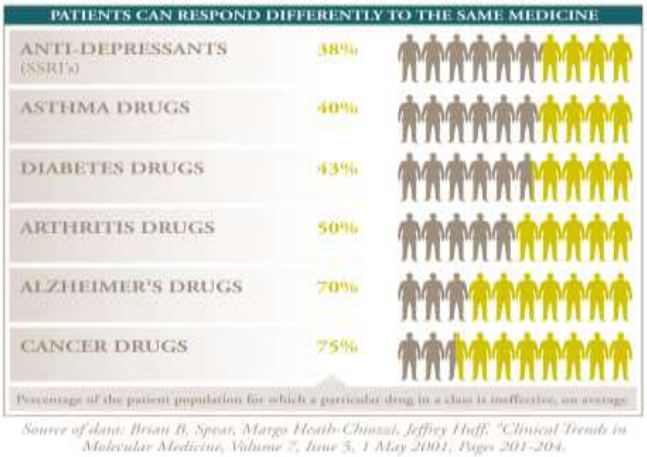

Fig 1: Trial and error treatment

Personalized medicine is the right medical system that promises to solve the aforementioned problems. For this to be feasible, information technology that integrates different scientific research and healthcare databases is required.

Nowadays, information technology is the road map to any successful activities. It there plays a vital role for helping physicians, health organization and drugs industries in acquiring the desired information towards improving health services through integration of scientific research and clinical data in databases of different locations. With the support of information technology in personalized medicine, studies of large-scale genome population and many automated processes involving DNA sequencing and spot-checking for genetic variation are becoming fast and reliable ways of identifying which variations are associated with specific disease [3]. Because of the importance of health information technology in gathering, analyzing and comparing the unique biology and medical history of patients with large-scale clinical outcome information with the intention to discover any risk and response of drugs huge amount of money is spent by private organization and governments. That is why, in his giving priority to health, president Obama of united states implements a nationwide healthcare IT, budgeting $19 billion as part of the Health Information Technology for Economic and Clinical Health Act (HITECH) which section of the American Recovery and Reinvestment Act (ARRA) 2009 [3].

2.0. The state of the art of personalized medicine

Despite the completion of human genomic project in 2003, personalized medicine goes beyond the genomic technology, as such it's regarded as broader medical health technology which encompasses genomics and molecular therapies as well as gathering, analyzing, integrating and storing clinical data and environmental history of patient, disease and drugs with an intention to provide and optimize preventive healthcare services. It is ubiquitous that any technology requires electronic devices that facilitate lots of activities as well as providing reliable and accurate results of findings. Electronic Health Record (EHR) is the key cornerstone of personalized medicine where appropriate clinical uses of genomic results in large quantity of data are handled electronically. Adoption and maintenance of EHR in personalized medicine will help guide health future development activities [4].

Another related area where current technology contributes much in personalized medicine is that consumer health informatics (CHI). In this health information system, electronic tools and technology application for consumer and patient improve healthcare processes in a way that a consumer can interact directly with electronic tool without the intervention of any healthcare personnel. The purpose of this interaction is to enable patient to better manage and if possible improve his health status through the use of individualized information [5]. The tools used in consumer health informatics include applications like telemedicine, online health calculators and other internet facilities such as e-mail. Some

sophisticated electronic device like for instance iphone has some inbuilt application such as weight tracker, food IQ and many others that assist patient in getting required health information [5]. With these advancements, personalized informatics reinforces personalized medicine in the sense that poor and uninsured patient can be able to have access to health-improving treatments and preventions.

To understand more about personalized medicine, let us look at the impact and challenges it has in cancer diseases with the influence of health informatics.

3.0. Personalized medicine and informatics in cancer

Generally speaking, the term cancer which is referred to malignant neoplasm in medicine is kind of diseases in which group of cells grow in an uncontrollable manner beyond the normal limit thereafter causing damage to adjacent tissues that are perhaps spread in other location of the body through lymph or blood. Cancer is caused by external and internal factors; the external factors include tobacco, chemicals, radiations, and infectious organism, whereas the internal factors include mutations due to metabolism, inherited mutations, hormones, and immune conditions [6]. Oncology is the branch of medicine that deals with the study, diagnosis, prevention and treatment of cancer diseases. From what is found in this research area, 13% (7.6 million) of all human death in 2007 was caused by cancer with 20, 000 people every day; about 5.4 million would get cancer and 2.9 million would die of cancer in developed nations with 6.7 million cases and 4.7 million deaths in developing nations [7].

Despite the fact that cancer is prevented and cured at certain stage, the morbidity and mortality rate is much, as such it is expedient to fully implement personalized medicine for the preventive and right treatment of cancer. Many "omics" such as genomics, transcriptomics, proteomics and metabolomics are most important tools used in personalized medicine that help provide information about the genetic variation, gene and protein expression and chemical reaction of molecules in the body. This information helps researchers and physician to have good understanding of disease and thereafter provide better diagnostic tools and treatments specifically for a particular type of cancer [3].

To implement personalized medicine, vast amount of scientific research, genomic and clinical data should be integrated in systematic and coherent way, couple with IT infrastructures tools support for healthcare professionals. In achieving this, the National Cancer Institute (NCI) initiated the cancer Biomedical Informatics Grids (caBIG) initiative in 2004, to develop and implement interoperable IT infrastructures and tools that will be used for effective and efficient management of genomic and clinical data across USA and around the world [8]. After the initiation caBIG it gained worldwide acceptance through the engagement of NCI with organizations in Europe, Middle East and Asia who embraced

caBIG as one of the solutions for their biomedical IT needs. In its operation, caBIG makes good use of electronic health records (EHRs) as an interoperable mechanism for linking clinical outcomes data with genomic information. With this advancement in interoperable IT infrastructures and tools in personalized medicine, making the connections between clinical and genomic information, a great improvements in translational research and decision support for improved patient medical care are achieved [8]. Another important area where caBIG plays a good role is in biomarker discovery where over 300 researchers use the repository of molecular brain neoplasia data web portal to analyse data from over 890 glioblastoma cases in order to identify biomarker for brain cancer [8].

4.0. Informatics challenges for personalized medicine in cancer

Albeit, all the success and wide acceptance of personalized medicine, it faces a lot of challenges especially from the informatics point of view of the state of the art used technology. Some of the major challenges include:

- ***Cost of implementation:*** Personalized medicine brings great benefit in prevention and treatment of cancer. Since the rational is to bring better solution for healthcare activities, the implementation of personalized medicine requires huge amount of money for building and management of genomic and clinical databases and other IT infrastructure that will enable researchers and clinicians have access to the integrated information. Another aspect that also requires money is the generation of clinical utility data which involve series of clinical trials. For instance, in 2003, the average price for phase III clinical drug trial to show utility of new companion diagnostic was approximately $119 million [9]. When we just look at this, funding projects in personalized medicine is quite challenging. Because of the changes it makes for the reimbursement system, many insurers can afford to incorporate genetic tests due to high membership turnover rate that cannot be beneficial to them. As a result tests are only reimbursed for the patient with manifested symptoms 3].
- ***Medical Education:*** one of the sensitive areas in personalized medicine is how to translate knowledge into clinical practice. Because the rapid advances in technology, biomedical research and medicine, it's expedient to find an efficient way to support clinical activities. It takes many years to adopt this technology throughout healthcare delivery because the scientific and medical advances outstrip the ability of clinician and healthcare providers to remain up-to-date on the latest medical information [10]. Most medical education institutions are reluctant to put

personalized medicine in their curricula, which seems to be like a stumbling block to the acceptance of the personalized medicine.

- ***Genetic Discrimination:*** Many employers and health insurance organizations take advantage of genetic information to discriminate against individual. It is shown [3] in a survey that about 68% of public express fear of genetic discrimination in employment and health insurance. This really contributes to the full participation of public in genetic screening and research programme. To fulfill the promise of personalized medicine, basic genetic nondiscrimination legal protection is necessary to encourage people participate fully in the programme.

- ***Instability of Power and Networks:*** This is an informatics challenge peculiar to developing nations especially in Africa. Personalized medicine is underpinned by high information technology infrastructures that use sensitive and sophisticated electronic devices which their functionalities require stable electricity and internet networks. Any deficiency in these, contribute to the hindrance of personalized medicine successful implementation.

5.0. Conclusion

Personalized medicine plays a vital role in transforming healthcare services into modern technology with aims towards providing preventive and appropriate treatment through the use genomic profiles of individuals, so that right medication is prescribed for right patient at the right time. It is supported by information technology infrastructures such electronic health records (EHR) and health information technology (HIT) in fulfilling its promise. It gained wide acceptance in its intention to improve healthcare of the society. However, personalized medicine faces some challenges especially in the reimbursement and genetic discrimination.

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