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PERSONALIZED MEDICINE, PHARMACOGENOMICS, AND HERCEPTIN: WHY AN INDIVIDUALIZED APPROACH TO THERAPY IS THE FUTURE OF HEALTHCARE

Delaney Graham (dqg1@pitt.edu)

PERSONALIZED MEDICINE

Ever since humans have been around, they have gotten sick. There have always been healers and medicine men to try and fix the illness. The common cold isn’t that bad—for people who have properly functioning immune systems—it might warrant a trip to the drug store for Nyquil and tissues but it’s not going to significantly affect one’s everyday life. However, there are many illnesses that do radically change a patient’s life. With today’s technology, doctors can perform surgeries to repair hearts that have been shredded with shrapnel and restore brain function impaired by a tumor compressing the organ. However, there is always more to be done.

It would be a significant contribution to science and society because then people would be able to have care tailored specifically to them, because not everyone responds to the same medicines. Not everyone has the same reaction to the same treatment.

There are drawbacks with every technology and personalized medicine is no different. Everything is, key word, personalized, so these drugs cannot be mass-produced like other drugs, such as Advil, can be. This technology, the process that goes into sequencing a person’s DNA and creating a unique medication for them is incredibly expensive and time consuming.

I believe that despite the possible negative aspects of the process, the future of healthcare is going to be personalized medicine, and it’s going to be a massive contribution to society, engineering, and individuals.

WHAT IS PERSONALIZED MEDICINE?

In 1953, James Watson and Francis Crick discovered the double helix structure of DNA, and fifty years later, the entire human genome was sequenced [1]. In just this tiny window of time, there was a revolutionary amount of knowledge produced and published about DNA. Since then, scientists have continued to study the compound with hopes of unlocking its’ secrets about health. One of the major focus points of this research is what is called “personalized medicine” [2]. There are many different factors involved in treating illnesses, such as “genetics, demographics, drug-drug interactions, disease states and the environment,” and every time there is a new patient there is also a unique combination of those factors [3]. Due to the various backgrounds of patients, no two patients have the same response to treatment. The dream that physicians have for personalized medicine, which is defined as the practice that “utilizes genomic and family history information to customize diagnostic and therapeutic inventions and improve health outcomes,” is that it can take a degree of that variability away [2]. When doctors have a deeper understanding of a patient’s genetics, they can pinpoint the cause of the illness and predict the result of treatment with a much greater degree of certainty. When doctors can control more aspects of a patient’s care, and have a better idea of what therapies will work, they can better evaluate the risks and benefits of a particular therapy for the patient. Ultimately, the goal of the personalization of medicine is to save lives. In a study of lung cancer patients at Sloan Kettering Cancer Center, the patients that received targeted drug therapies for their genetic material had a longer life expectancy [4].

Why Personalized Medicine Is Significant

Currently, personalized medicine is not the normal course of treatment for the average patient. Instead of therapy tailored to each individual, it is based on “population statistics” [5]. In an attempt to deal with the overwhelming number of different patients and different ailments, physicians separate their patients into groups often defined by known symptoms or similar lab test results [5]. This wide array of patients is then treated in the same fashion, but the drugs can’t help everyone and can’t help everyone to the same degree. When medicine is personalized, those who are unable to benefit from the standard therapy will still have hope of recovery.
I believe personalized medicine is of significance to society, to engineering, and to individuals. The preservation of life is perhaps the most significant contribution any technological advancement can hope to make to society, and personalized medicine can do that. By discovering cures for each individual person, personalized medicine has the ability to end the needless suffering of millions of people. Personalized medicine is important in engineering communities because as with any new technology, it opens the door for unimaginably more possibilities. It opens the door for curing illnesses that were once terminal diagnoses. It opens the door for preventing illnesses from ever developing. Personalized medicine will also touch many people’s lives in a very intimate way. I know personalized medicine would have an impact on my own life because my mother is a breast cancer survivor. She hasn’t been in remission long enough to technically be considered a survivor, but that’s what she is to me. My mother had wonderful doctors treating her, and she was very lucky to have therapy she did, but there is always the possibility for better drugs that could have resulted in fewer symptoms and not caused her to be in so much pain. There are reasons for the delayed use of this technology, such as “lack of education by prescribing physicians regarding available tests, lack of consensus on interpretation and use of genotype results, and scarcity of trials demonstrating testing” [2], but I believe that further study of personalized medicine will be more than worth it because of the positive impact it will have for so many people.

**WHAT IS THE PROCESS FOR CREATING PERSONALIZED MEDICINE?**

**What Are Pharmacogenomics and How Are They Made?**

Pharmacogenomics is a specific subset of personalized medicine. Pharmacogenomics (PGx) are drugs, and study of the patients’ response to said drugs, specifically designed by utilizing a patient’s genetic information [2]. It’s impossible to determine how to tailor drugs to a patient’s unique DNA if the DNA is not sequenced and evaluated. The specific DNA of an individual is determined by the combination of the four bases, adenine, guanine, cytosine, and thymine. The sequence of these bases is determined by electrophoresis, which is when the compound is placed in a gel that has a current running through it [1]. Small molecules can travel faster and farther than larger molecules. The separation of the bases at the end of the experiment is what the scientists use to determine the proper sequence. Once the sequence is determined, scientists can determine where the genetic anomaly is. Only after that can the creation of the pharmacogenomic begin because now the scientists know what they need to fix and have a better idea of what the patient’s response to the drug might be.

**Why DNA Sequencing Is Significant**

DNA sequencing is significant to society because of the numerous applications it has. All living organisms have DNA, and by sequencing DNA, we can understand why things grow the way they do, react to stimuli they way they do, and why they look the way they do. Once DNA is sequenced scientists are only limited by their creativity as to what to study. Research has been done on different animals fluorescence, anti-aging properties, and methods of healing.

Engineers can take advantage of DNA sequencing by determining the best applications for it in today’s society. Bioengineering is the field of engineering that most often works with living organisms, but because DNA is a chemical compound, chemical engineers also work with it. Sequencing DNA was the beginning of the revolution of genetic modification and genetic engineering because sequencing the DNA enables scientists to understand and modify it.

DNA sequencing is significant to me because I am interested in bioengineering and chemical engineering. I love chemistry because I like the reactions and bonds and compounds that are so crucial to chemistry, but I like those topics even more when they are applied to people. I am significantly impacted by the technology of DNA sequencing because then I have the opportunity to become a genetic engineer that can sequence, understand, and modify DNA to create cures and heal the sick.

**WHAT IS A SPECIFIC EXAMPLE OF AN APPLICATION OF THIS TYPE OF TECHNOLOGY?**

Herceptin is a type of personalized medicine. When a woman is diagnosed with breast cancer, many tests are done to determine what type it is. Because my maternal grandmother also had breast cancer, the doctors analyzed targeted portions of my mom’s DNA to determine if the cause was hereditary. It wasn’t hereditary; however, the results revealed a genetic mutation was causing an overexpression of the HER2 gene. This is a problem because the HER2 gene causes the production of the protein known as the HER2 receptor [5]. A healthy cell has about 20,000 HER2 receptors, but a cancerous cell can have as many as 2,000,000 receptors [5]. The HER2 receptor tells the cells to grow and multiply, and this is what leads to the
uncontrollable growth of this specific cancer [6]. When the doctors realized that this is what was causing the tumor to grow inside my mother, they were able to determine the proper drug therapy for her case. Herceptin is the common brand name for trastuzumab [6]. It works by binding to the HER2 receptors and blocking their ability to transmit the signal necessary for growth [6].

A POSITIVE CONTRIBUTION TO SOCIETY, ENGINEERING, AND INDIVIDUALS

As a young woman who was deeply affected by a loved one’s illness, it is impossible for me not to see all of the positive things that can come out of personalized medicine. I believe that personalized medicine will be our future because of the possible lives that can be saved and number of illnesses that can be eradicated. As a responsible engineer I understand why there are drawbacks to personalized medicine as well. The technology is new and the process is time consuming; both of those things add up to personalized medicine being very expensive. However, proponents for personalized medicine also hope to cut costs by cutting down on the number of drugs physicians prescribe with a “scattergun” technique [7]. Instead of writing prescriptions in a trial and error fashion, personalized medicine will allow the physician to prescribe the exact right medicine and the exact right dosage, which will result in a decrease in the $177 billion attributed to the cost of drug-related morbidity and mortality in the US [7]. More than that, I believe that personalized medicine is so important because with it healthcare can be transformed and a patient’s quality of life can be improved because their unique therapy gives them a greater chance of healing.

SOURCES


ADDITIONAL SOURCES


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