

Personalized Medicine: The Future of Public Health

Josiah B. King '23

Introduction

After being wrenched by Covid-19, public health has begun adapting and incorporating new found scientific knowledge. We live in a world where every individual is different. Because of this consistent difference, no two people have the exact same response to any public health treatments. That includes drugs, supplements and behavioral therapy. It is essentially impossible to know exactly how certain drugs and medical treatments will affect a person just because of how complex the human body is. Today, doctors and other health care professionals make educated assumptions based on generalizations and a trial-and-error process in order to offer you the best treatment they can. While this method has proven to be rather effective, this form of medical therapy can be improved exponentially. A personalized form of medicine would provide patients with more effective treatments and would potentially prevent patients from suffering from negative side effects of treatments. The more we learn about the human body and its biological functions, the more public health can move away from the generalized way of practice that is commonly used today. Modern day microbiology has made personalized medicine possible. In order to make medicine more personalized one would need to biologically profile patients and use the results as a guideline to decide how to treat the patient in the future. Many wealthy high-class people are already using personalized medicine to their benefit. A strong argument can be made that everyone should be benefiting from this compelling medical practice. One can even go as far to say that it is the patient's right to have medicine as personalized as possible because, as history has taught us, when anything is attempted to be generalized, minorities tend to get stuck with the short end of the stick. If the scope of public health became personally tailored to each individual, society would benefit as a collective by increasing treatment efficacy and decreasing the prevalence of adverse effects in medicine.

As stated earlier, the idea of personalized medicine is dependent on biological profiles. There are many ways to biologically profile someone, but only a few of which can realistically be utilized with today's scientific understanding in the realm of public health. That of which include genomics, pharmacogenomics, proteomics and microbiome population. Other forms of biological profiling exist but the current understanding of these fields is too underdeveloped to implement into public health any time in the foreseeable future.

Perhaps the most popular form of biological profiling takes place in the field of genomics, the study of the DNA that makes up the human genome. While

genomics is a powerful field, it is much more useful when used in conjunction with other areas of study. Pharmacogenomics is a sort of sub-focus of genomics and is the study of how drugs interact with the human genome. Your genes make up your genome and encode for the production of enzymes. These enzymes are responsible for metabolizing drugs. This is where differences in how people respond to drugs often arise. In one patient a gene may encode for the production of many enzymes and in another patient the same gene may encode for the production of little to no enzymes. This explains why many drugs can work perfectly in some and not work or have adverse effects in others. Genomics are already sporadically used in public health. It is commonly used for patients dealing with inflammatory bowel disease. One of the frequently prescribed medications for IBD causes terrible side effects if metabolized too quickly. Pharmacogenomics can identify how quickly the patient is likely to metabolize the drug and ultimately reveal if it is a good drug for the patient to take (Harvard health). Genomics can also be used to assess a patient's susceptibility to addiction to a specific drug. Many mutations and variations in genes have been identified and linked to substance abuse. For example, certain variations in the genes that code for ADH1B are associated with alcohol substance abuse (Edenberg *et al*). A specific difference in the μ - opioid receptor is directly associated with opioid abuse disorder (Russell, Jordan T *et al*). Other substance abuse disorders that have associated gene mutations include cocaine, heroin, cannabis and nicotine. Research is constantly ongoing to uncover new links between substance use disorders and genetics.

The Promise and Limitations of -omics

Assessing one's genomics can also uncover pesky mutations that can lead to fatal conditions and diseases. Many of these mutations can be managed if discovered early enough. For example, Wilson's disease, an autosomal recessive sex-linked disease, causes people to store too much copper in essential organs like the brain, liver and eyes. If this condition is not discovered early enough then it can lead to organ failure and ultimately death. If discovered early, people with Wilson's disease can live normal and healthy lives by making a few simple changes to their diet and maintaining a regular medication regimen (genome.org). While genetic linked diseases are rare, the survival rate of those with them when untreated is extremely low. Therefore, it is important to identify gene linked diseases as early as possible.

Similar to genomics, Proteomics, the study of proteins, can be used in personalized medicine.

Proteomic diagnostics are relatively standard practice in the operating room. When a biopsy is taken, it is common for the biopsy to be analyzed with proteomics in a lab. Proteomics can reveal if cells are cancerous or if tissues are infected. For example, if a breast tissue sample over expresses the protein HER2 then it is likely that the tissue is made up of cancerous cells. This type of proteomic diagnosis also can tell physicians the best way to treat the patient. When dealing with the overexpression of HER2, inhibiting the protein with an antibody has proven to be an effective strategy (Horimoto, Yoshiya *et al.*). Proteomics can also be used to effectively diagnose and treat other diseases including cardiovascular and neurodegenerative diseases. The field of proteomics will only grow and become more useful in public health as research continues to associate the expression of proteins with certain diseases and conditions.

Genetics and proteomics both use biomaterials that are associated with the living human body, but the final major way to biologically profile someone focuses on the organisms that live on and throughout the human body, the microbiome population. The human body is covered and filled with microorganisms such as fungi and bacteria. This abundance of microorganisms makes up the human microbiome. Research has proven that the microbiome in the gut has an extensive impact on one's overall health. The existence and absence of certain bacteria in the gut can be associated with multiple conditions including depression and obesity. These good and bad organisms can be identified with a simple bacterial culture, a procedure that is often taught in Introduction to Biology classes. If a patient has an unhealthy microbiome, they can replenish their good bacteria using probiotics or a fecal matter transplant (Harvard Health). Microbiome research is not as thoroughly researched as genetics and proteomics but the area of study is making large strides in the medical field. It is probable that the human microbiome will become exceedingly prevalent in public health within the next few years.

There are undoubtedly many amazing things that personalized medicine can accomplish. These near miracles create a strong case for the implementation of personalized medicine into public health, but perhaps even more compelling is how harmful general medicine can be. As mentioned earlier generalized medicine entails a fair amount of trial and error-based treatment. The process often makes people give up on bettering their health. Countless side effects often make the patient feel worse than before and the duration of the process develops a mindset of hopelessness. For example, when tending to patients dealing with depression, physicians will often prescribe

an antidepressant. The problem is the anti-depressant often increases frequency of suicidal thoughts for as long as months. Physicians advise the patient to stay on the medication for an extended amount of time before determining if the medication is right for them. The idea is that the body will adjust to the anti-depressant and the side effects will wane away but it is not uncommon for the side effects to persist. Once a surmountable amount of time has passed and the doctor can confidently determine that the drug isn't right for the patient, then the process must be started again with another antidepressant. This cycle is continued until the perfect match is found but there are cases in which the perfect drug is never found. 50% of the failed depression medication treatments are attributed to non-compliance; many patients are not willing to deal with the horrible side effects that the drug creates. It is important to note that 80% of those who are treated for depression see improvement after six weeks. So those who suffer from depression should still seek medical treatment (Depression Statistics). On the other hand, it is also important to understand these six weeks are often a rigorous period and it is even more difficult for the 20% of patients who must venture past the six-week period to see any sort of improvement. While depression treatment is probably the most prevalent, other forms of treatment require the same amount of patience and determination such as anxiety and certain digestive malfunction treatments. Personalized medicine would shorten this process, help patients avoid adverse side effects and ultimately allow more patients to be successfully treated.

Barriers to Personalized Medicine for All

Minorities in particular are harmed the most by general medicine. The FDA openly acknowledges that clinical trials lack minority participants (FDA). This discrepancy in minority targeted treatments can be observed in the most prevalent condition among children, asthma. The standard prescription drug for asthma, albuterol, does not work as effectively in African American and Puerto Rican children than it does in children of European descent (Weiler, Nicholas). This efficacy discrepancy directly correlates with the uneven ethnic distribution in clinical trial representation.

Minorities and society as a whole would benefit from personalized medicine financially. As stated earlier, personalized medicine can help doctors provide patients with the most optimal treatment. This direct optimization will alleviate the trial-and-error process used today and in turn save the patient from having to pay for more visits, more tests, and more

medications. Personalized medicine's direct fashion will allow patients, health care workers and insurances to save their money and time.

Although there is no doubt personalized medicine would be beneficial, there are a few reasons why it is difficult to fully implement as of now. The most overarching problem lies in the initial cost. While over time personalized medicine is financially beneficial, the cost of a biological test is a daunting investment. A pharmacogenetic test today costs between \$250 to \$500. This price range is not feasible for many people and insurance often will not cover the test unless it is proven to be absolutely necessary (A. Werth and S. Starr, personal communication). Also, many people may not want to know what diseases or conditions they are prone to develop or know what chronic illnesses they already have. Many people are not eager to know more about their health. "Ignorance is bliss", as the old saying goes. Knowing this type of information could cause other health issues such as anxiety and nocebo effects. Fear of the unknown often fuels the scrutiny of new scientific advancements. In public health, the community is often quick to rebuke new treatments but fail to realize that most treatments have already faced the same doubts before.

Conclusion

That being said, scrutiny is not necessarily a bad thing when it comes to scientific advancements, especially when dealing with health. However, when discerning the pros and cons of something it is important to have a substantial foundation of knowledge on the subject. When it comes to personalized medicine, there are a few things that you should be weary of. First and foremost, patients need to be careful of who they give access to their biological profile. There are many genomic DNA sequencing companies that offer to tell customers something based on their genome. Many of these companies are not very reliable in their readings, but those of higher quality do return some beneficial information. Participating in these types of services is risky because the customer is giving a company access to their genome. This type of information can be sold and lead to genomic discrimination. Discrimination based on one's genes is illegal thanks to the Genetic Information Nondiscrimination Act of 2008. However, if the genomes of applicants for a job were discreetly available online it would be difficult for a hiring company to pass up the opportunity to narrow down who would be the best addition to their organization based on the applicants' genomic make up. This practice is in no way fair because one's genome is something they cannot change but hiring the right applicant can save companies thousands of dollars. When it comes to money, we know that people are willing to do all types of things and this is no exception.

While personalized medicine will be a great addition to public health, it is important to understand how it might be misused in order to protect yourself and your loved ones.

Medicine is constantly progressing and improving, so we can assume that a time of more personalized medicine will arise. Until then it is important to keep in mind that general treatment is not perfect and never will be because everyone is different in so many ways. When a doctor or a healthcare worker provides you a treatment that doesn't quite work for you, I encourage you to refrain from losing confidence in your physician. Understand that health care as of now is an experimental process. You and your physician must work together to find what methods of treatments work best for you and your body.

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