Exploring Competing Visions of a Personalized Healthcare Experience

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On my honor as a University Student, I have neither given nor received unauthorized aid on this assignment as defined by the Honor Guidelines for Thesis-Related Assignments

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Introduction

It is no secret that medicine is constantly evolving. From early genome mapping to modern day medical technology, healthcare practices are constantly being revolutionized. Research efforts and business diversification have been two key driving forces of these movements, which has contributed to the new idea of 'precision public health,' also referred to as personalized medicine (Steffen, 2013). Advocates of precision medicine argue, "that adopting cutting-edge big data approaches will allow public health actors to precisely target populations who experience the highest burden of disease and mortality, creating more equitable health futures (Kenney, 2019)." My STS research will utilize multiple case studies to analyze two sides of this sociotechnical imaginary: the self-evidently desirable future of personalized medicine and the drawbacks including legal, social, and ethical concerns.

Background and Driving Forces of Precision Medicine

The definition of precision medicine is best given by the National Research Council's Toward Precision Medicine which states precision medicine as: "The tailoring of medical treatment to the individual characteristics of each patient…to classify individuals into subpopulations that differ in their susceptibility to a particular disease or their response to a specific treatment" (Ginsburg, 2018). Precision medicine describes a model for health care delivery that utilizes data, analytics, and information. It embraces a patient-centered engagement, digital health, genomics, molecular technologies, data science and data sharing. Preventative and therapeutic methods are developed and personalized to those who will benefit (Ginsburg, 2018).

Precision medicine is driven by a large network of forces. It includes both individual and public engagement, health care professionals, end-users, large data sets, technological resources, integration into the healthcare system, and sustainable economic models. Additionally, personalized medicine relies on the collaboration of pharmaceutical and biotechnological industries with academic industries. Patient data is made available by industrial players from clinical trials to academic and scientific researchers for analysis of results and continued research. These results are then translated to industry partners for input into bioinformatic tools. Eventually, these research developments will have the end goal of implementation into the healthcare network (Agyeman, 2015). Thus, the success of this sociotechnical imaginary lies in the cooperation and coordination amongst a very large network, which is anything but simple.

All stakeholders of precision medicine are involved in shaping the system. Researchers must determine the best practices for R&D. Health systems must offer tools and systems that allow for the adoption of precision medicine as opposed to current methodology. Biotechnical and pharmaceutical communities must design secure genomics-enabled systems for actionable use in the health care and community settings. Policy makers must address implementation which includes return of results, privacy, and confidentiality. Additionally, they must determine regulations and economic incentives to align all stakeholders. Finally, patients must adjust to individualization of healthcare and new methods that it might entail (Ginsburg, 2018).

With personalized medicine, it is now possible to expand beyond the scope of typical broad distinctions such as demographics and socio-economic factors and dive into more specialized methods of classifying individuals. Melanie Swan studies the importance of the big data movement in driving the path towards precise medicine. ‘Big data’ refers to, “the collection of voluminous amounts (e.g., petabytes and exabytes) of a variety of unstructured and semi-

structured data that is now possible, cheap, and occurring in most sectors of the economy (Swan, 2012).” It acts as an imaginary of its own due to its broad expansion beyond just the healthcare system. From a macro perspective, large longitudinal datasets containing health related information become a public resource, and there is a greater worldwide ability to respond to outbreaks and other concerns. From a micro perspective, individual analysis provides the ability to study personal trends and develop viable suggestions for health issues and concerns (Swan, 2012). Hence, big data promises an exciting path for precise medicine and remains a driving factor for implementing this imaginary into a mainstream reality. It represents a sociotechnical phenomena with the powerful ability to transition into a world in which both human and data entities exist productively in mutual collaboration.

Beyond just the movement towards big data, Julius and Jan Steffen discuss an additional driving force for personalized medicine: business diversification. They describe personalized medicine as a corporate growth strategy addressing past concerns and challenges in the pharmaceutical drug industry. Past challenges include patent expiries, generic competition, little R&D success, and political restrictions (Steffen, 2013). Typical R&D methods have relied heavily on the “blockbuster model,” which relays the idea that a smaller number of products provide a higher revenue. However, until 2015, six out of ten of the largest pharmaceutical companies suffered from patent expiries accounting for more than 50% of total sales in addition to a projected negative sales return on R&D (Steffen, 2013). As a result, pharmaceutical executives began to seek business diversification. Personalized medicine became appealing because it was not nearly as subject to previous stated challenges and concerns. For example, with patent related concerns, personalized medicine offers such targeted therapies with specific modes of action that it is nearly impossible to copy by generic manufacturers. Additionally,

revenues from personalized medicine are driven by margins instead of volumes as seen with blockbuster drugs. With this perspective, as pharmaceutical companies make major investments into R&D, they are diversifying corporate strategy and driving the emergence of personalized medicine (Steffen, 2013).

Success and Potential of Precision Medicine

To begin the analysis of the potential benefit of personalized medicine, let us narrow the scope to look at Herceptin, a recognizable success story for pharmacogenomics and precision health. Herceptin was approved by the FDA in 1998 and became one of the first in the generation of personalized medicine (Gabe, 2012). Herceptin acts as a prototype for personalized medicine by serving as a guided missile for chemotherapy targeting breast cancer cells (HER2+). Typical methods of chemotherapy involve an aggressive attack of both healthy and cancerous cells, so this new method offers a medical fantasy with minimal collateral damage (Kenney, 2019). The American Society for Clinical Oncology concluded that treatment with Herceptin was associated with a 33% reduction in the risk of death and a 46% reduced risk of the return of cancer (Gabe, 2012). This provides significant hope for what the future of medicine could look like as science and technology continue to advance in this field and business models adjust accordingly. Herceptin laid a base for the imaginary of precision.

An additional example of the powerful benefits of precision medicine is in the field of pediatric cancer patients. A difficulty seen in pediatric oncology as opposed to adult oncology is the fact that the genetic makeup of pediatric tumors has less targets that adult tumors. However, due to new precision medicine featuring “new combinations of treatment modalities, focus on cytotoxic chemotherapy to aid those most at risk, and the discovery and refinement of novel

biologic markers," the survival of pediatric leukemia and tumor patients has significantly increased over the past few decades (Nassar, 2020). Big data and precision medicine have greatly increased the understanding of childhood cancer and have given researchers the ability to increase survival rates and improve toxicity outcomes. Overall, the current trajectory of precision medicine points towards even more practical applications of precision oncology both children and adults alike through the combination use of big data and prior knowledge.

In addition to providing the ability to target specified genetic mutations, personalized medicine also provides the ability to predict an individual's likelihood for developing certain conditions or diseases. "The ever-expanding list of identifiable genetic markers and mutations is giving researchers powerful tools to predict and prevent debilitating diseases by identifying those patients who are more at risk" (Nassar, 2020). As our emerging network of actors involved in precision medicine continues to develop, the future of healthcare becomes more defined.

The Wharton School of the University of Pennsylvania explains how precision medicine goes beyond just genomics to include factors such as phenotype in addition to how a patient interacts with the outside world. Pharmaceutical companies will be trying to work more closely with physicians to develop solution-based programs with more holistic views of patients' history and health which should result in a dramatic improvement to therapeutic outcomes. Precision medicine expands beyond traditional medical techniques by developing non-traditional partnerships and relationships. For example, big data has the ability to provide patients with a new level of care that is informed by the data of nearly every patient before them through use of an in-memory data management and application platform. Thus, physicians can now take advantage of clinical insights from massive amounts of data from patients in the United States

(Wharton, 2016). Ultimately, big data is a massive contributor to the success of personalized medicine and provides an exciting hope for precision medicine.

Concerns Associated with Precision Medicine

To begin analysis of potential risks and threats posed by precision medicine, let us take another look at the case of Herceptin. Although Herceptin seemingly brings clear positive impacts in the medical community, it must be mentioned that the glimmering hope of a cure for cancer obscures the reality that targeted chemotherapy methods still could have underlying issues in clinical practice. It is noted that although Herceptin had great success in its short trial phase, side effects are likely underestimated in comparison to drug effectiveness, particularly the lack of long-term toxicity of the drug involving effects on the heart (Gabe, 2012). The focus turns attention towards a moral imperative for drug research and development which seems to fully overwrite clinical uncertainty. Nonetheless, this type of precision medicine has potential to offer modern technology and humanitarian solutions to the highest priority public health issues. It is a massive step towards a new future of medicine and every new development is accompanied by a little bit of uncertainty and skepticism.

As with all emerging technologies and developments, power and wealth tend to be of high priority. For example, let us look at the controversial case of Myriad Genetics, a leading genetic testing and precision medicine company. In 1997, Myriad monopolized the BRCA1 and BRCA2 genes by patenting these DNA molecules. The initial discovery of these genes was groundbreaking; the Myriad team was able to find a genetic linkage to breast and ovarian cancer and was able to locate the gene with mutations responsible (Baldwin, 2013). Quickly after discovery, Myriad Genetics filed patents for BRCA1 and BRCA2 becoming the sole commercial

testing service for these mutations. Most would assume that this breakthrough discovery and efficient testing would gain positive attention, but this was not the case. Countless researchers not affiliated with Myriad Genetics attempted BRCA clinical research, but Myriad's monopolization on these mutations soon shut it down (Baldwin, 2013). It was noted that, "to the large majority of researchers who had been following closely Myriad's public statement, it seemed that Myriad was willing to block scientific research to turn a profit" (Baldwin, 2013). Unfortunately, the exclusive gene patent of the BRCA1 and BRCA2 genes held by Myriad had a detrimental impact on the community. By outlawing further clinical research and support by other companies, Myriad failed to develop a promising therapeutic. Although, this case was brough to the U.S. Supreme Court by 20 different medical organizations, geneticists, patients, and organizations in which the court unanimously ruled that these genes could not be patented due to their mutations (Baldwin, 2013). This analysis shows that business decisions about how to use exclusivity require separate attention in the causal network of personalized medicine. It ultimately raises concern that scientific research and discovery will be monopolized due to the desire for profit and power.

Additionally, the desire for profit suggests that this movement could exacerbate income-related inequalities in healthcare due to the less-than affordable nature of precision medicine. Thomas Ferkol and Paul Quinton study a notable example of rising income disparities with the case of a new precision drug for cystic fibrosis (CF) (Ferkol, 2015). CF has no cure, but past treatment methods have focused on down streaming CF effects which have resulted in increased life expectancy. One precision drug currently on the market, ivacaftor, treats G551D and has the ability to change the clinical course of nearly 90% of all CF patients (Ferkol, 2015). However, it comes with a steep price tag of more than $300,00 annually. Equally expensive is Orkambi

which targets the delF508 mutation. Over the course of a patient's life, it is expected that they would spend ten to fifteen million on this drug, which leaves its use in the hands of the nation's wealthiest patients (Ferkol, 2015). Thus, we raise the painful questions: Does clinical effect justify exorbitant cost? Will precision medicine intensify the gap between rich and poor? Ivacaftor and Orkambi are only examples of possible financial trajectories that precision medicine could follow. Driving forces of this sociotechnical imaginary must direct themselves in a manner that compliments both the end-user and the producer while minimizing social damage.

It is important to also look at personalized medicine beyond just a business and scientific standpoint and analyze it from a social and societal perspective. Since medical treatment has always been relatively standardized, race and ethnicity generally does not play a role in treatment types. However, the progression towards personalized medicine does raise the concern of whether it will be equally beneficial for everyone. A study conducted by a team from the Precision Medicine and Health Disparities Collaborative explores African American and Hispanic perspectives on their perceived benefits and barriers of precision medicine through semi-structured focus groups. Before analysis, it should be noted that this study is subjective and might not be fully representative of the population. Nonetheless, it does provide a unique perspective of a potential social concern associated with precision medicine. To begin the study, the individuals were read a definition of precision medicine to make sure they had a basic understanding. Next, they were asked a series of nine questions related to their concept and opinions of precision medicine. The questions were relatively basic including ones such as their thoughts on precision medicine and their perceived accessibility of precision medicine.

After all participants answered the questions, researchers were able to analyze results. Both African American and Hispanic participants believed that precision medicine did have

similar benefits and barriers. Although, African Americans had high concern that racism would affect the benefits and non-genetic information could be misused. This was based on the idea that they would be judged based on socioeconomic status. Participants also raised concern about the integration and delivery of precision medicine in the healthcare system since the current system does not provide the same health care quality and accessibility across all patients. Majority agreed that they felt a lack of coordination between insurance, healthcare providers, and patients. They believed that the level of care and accessibility lied in insurance and wealth. All in all, majority of individuals were optimistic about the benefits of precision medicine but also were very concerned not about precision medicine, but "the context in which precision medicine would need to function so that broad communities can benefit from these translational innovations in clinical and biomedical care" (Yeh, 2020).

Discussion

It must be mentioned that much of the completed analysis is based on society's subjective points of view focusing on the "what if" and not necessarily the "what is." Precision medicine remains an imaginary of healthcare. For example, even established drugs like Herceptin still require more clinical research and analysis before becoming "normalized." Although I have listed examples of personalized medicine existing and in practice, it still has to prevail as a full system and develop appropriate coordination among the large network of actors and stakeholders. To say the least, it is a work in progress.

When examining the benefits of precision medicine, we are able to understand the vast potential it offers. Personalized medicine offers a glimmering hope for an answer to countless diseases and disorders. Big data provides the ability for researchers, pharmaceutical and biotechnical companies, and healthcare providers to work collaboratively to provide

individualized therapeutics and treatments for patients. “The advent of precision medicine would entail changes to every facet of modern health care.” (Wharton, 2016). Ultimately, datafication of bodies renders the ability to address long-standing challenges of individual and collective life through precision, personalization, and prevention.

As healthcare is being reconstructed, we must commodify this information to address legal, social, and ethical issues. The Myriad case study depicts how personalized medicine provides power which drives profit. It raises concern that a central value of personalized medicine would be power and profit, which might impact the level of research and care that patients receive. Agencies should determine an effective way to give credit to breakthrough discoveries while minimizing monopolization and legal disputes. Additionally, the sheer price of precision medicine poses a potential social issue. If precision medicine is only available to the elite and income-related inequalities are exacerbated through this form healthcare, then we must look at whether it is worth it. Hopefully, once precision medicine becomes more mainstream and less novel, the high price of treatment will begin to decline and normalize. The case on racism and ethnicity also provides valuable insight to individual’s perspectives on the perception of precision medicine, and it draws attention to values that might not have been previously addressed. Does precision medicine currently account for all social statuses and races? It is important that all stakeholders align values whether that be profit and power, transitional breakthroughs, improved patient treatment and therapeutics, etc. to develop a fully integrated, cohesive system.

With all in consideration, personalized medicine remains at the forefront of the future of healthcare. The sociotechnical imaginary requires coordination between a large network of end-users, researchers and scientists, academia, caregivers, technology, and socioeconomic players.

All forces must work together to provide technoscientific progress in which research and development can bring humanitarian efficiency to a new world of medicine while combating related concerns.

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