PreScouter

How Is Personalized Medicine Being Applied and Adopted by Industry?

Research Support Service

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We present here a handful of examples from some recent advances that showcase how personalized medicine is transforming healthcare by improving precision in diagnosis, prevention, and treatment of a variety of conditions that contribute to a significant fraction of disease burden worldwide.

Executive Summary

The world is amidst a revolution in personalized medicine — also called precision medicine (PM). The approach relies on increasing treatment precision by identifying a scientifically rigorous patient classification criteria and thereby narrowing the eligible patient cohort, until the approach is precise enough to be "personalized" for an individual patient. Regardless of the semantics, the unprecedented growth of precision/personalized medicine and the transformative healthcare advances fueled by this revolution are now undeniable.

The industry has long recognized the promise of personalized medicine, with many new entrants in the last decade leading the way and offering molecular diagnostic services and comprehensive genomic testing for cancer and other diseases. Forecasts of the total size of the personalized medicine market in 2025 range from $100 billion USD to over $2 trillion, due to varying definitions of the market, with most research firms estimating a CAGR of 10–11% over that time period.

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$100B **$2T**	**10-11%**

Executive Summary

This report reviews the potential and recent developments of personalized medicine in the following 6 disease areas in addition to a closer look at the industry and key players in the field:

1. **Cancer**
2. **Regenerative Medicine**
3. **Diabetes**
4. **Cardiovascular Diseases**
5. **HIV**
6. **Alzheimer's Disease**

What is next for personalized medicine?

Converging technologies will play a vital role, ranging from advances in acquiring, processing, and interpreting multiomics data based on approaches such as AI to novel ways to deliver personalized therapies, including targeted immunotherapies and CRISPR-Cas9 gene editing (two topics which merit separate reports, and which are only briefly discussed herein).

In addition, government and industry incentivization of precision medicine research, policies shaping increased sharing and democratization of scientific data, and the rise of electronic health records are key aspects that will shape the future of personalized medicine.

INTRODUCTION

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What is personalized medicine?

You are unique and therefore your therapy should be too.

In contrast to **conventional medicine**, where evidence from multiple studies is used to develop somewhat **rigid and protocol-based treatment guidelines** for a patient profile that represents a statistical average from multiple cases, **personalized medicine focuses on tailoring the therapy** based on unique characteristics for a class of patients — or if possible, for each individual patient. The more detailed and accurate the stratification of patients, the more customized and precise the therapy becomes.

Traditionally, this stratification has been achieved by the identification of unique patient-specific biomarkers that are mined through different diagnostic methods that analyze biological fluids and/or tissue biopsies. However, rapid advances in sequencing, bioinformatics, and AI have expanded the focus to deriving these stratification insights through the use of **multiomics**, which can include:

- genomics (DNA)
- proteomics (proteins and modifications on them)
- transcriptomics (coding and noncoding RNAs)
- metabolomics (metabolites)
- epigenomics (modifications on DNA)
- microbiome (diversity of microorganisms in your gut, for instance)

How will personalized medicine affect drug manufacturing protocols?

Large-batch production may become a thing of the past, and that's not necessarily a bad thing. **Single-use technologies** that produce small batches of drugs are safe and effective and don't have the financial burden of fixed capital investments and constant equipment upkeep.

Personalized medicine will not only change the way patients are diagnosed and treated, but will also upset current drug manufacturing protocols.

On the other hand, individualized drug therapies will disrupt many of the automated processes that have been tested and validated under quality control requirements. This could mean a shift in manufacturing to manual labor, which would require new production facilities and altered supply-chain logistics.

Many current personalized treatments (such as chimeric antigen receptor (CAR) T-cell therapy) involve manufacturing products using a patient's own cells. This type of therapy is a far cry from the "simple" manufacturing of a drug in-house and exporting it to facilities that directly market to patients. Instead, it is a complex arrangement of appropriate shipping conditions, quality control, and safety requirements. *And this is all for a single patient.*

How personalized medicine will ultimately affect manufacturing and distribution is unclear, but the industry will need to adapt to fulfill individualized production needs.

How will personalized medicine affect healthcare costs?

It seems likely that specialized treatments made for individuals or small groups of people would increase costs because everyone would require individualized drug production. On the flip side, genomic sequencing that creates a roadmap for precision treatment decisions is **not as costly as it was 15 years ago**, and informed drug targeting could reduce the overall cost of healthcare by addressing the underlying causes immediately. Perhaps, it will be most interesting to observe how insurance companies react to this treatment paradigm shift.

Historically, insurance companies have taken a very conservative approach to coverage of genetic testing. To circumvent this problem, US lawmakers on both sides of the aisle are drafting legislation like the **Advancing Access to Precision Medicine Act** that would allow states to apply for exceptions to the federal medical assistance percentage rate to cover whole genome sequencing clinical services for children whose diseases may have an underlying genetic component.

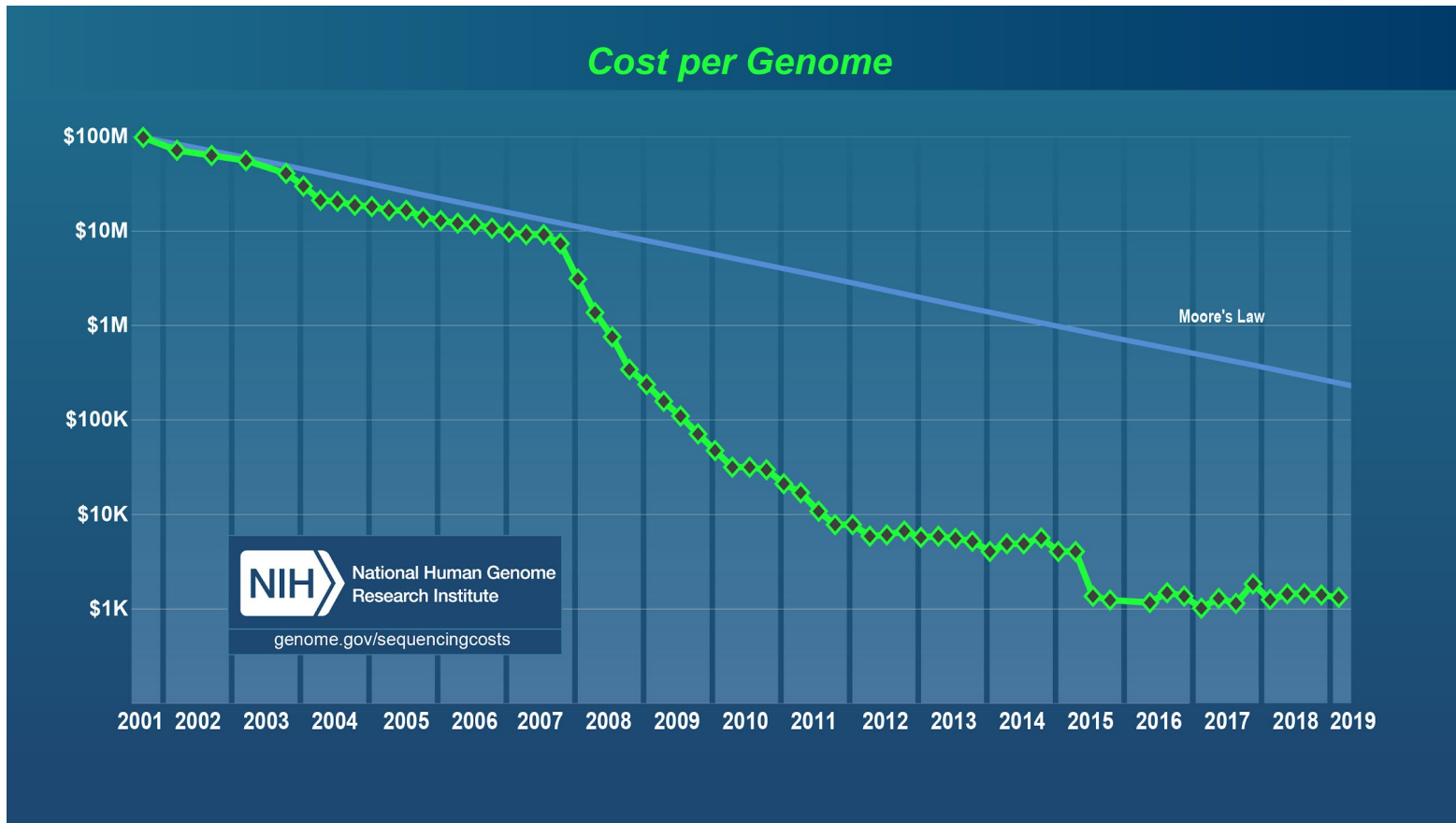# How will personalized medicine affect healthcare costs?

Figure: *How the cost of sequencing technologies have decreased from $100M per genome in 2001 to about $1K in 2019.*

Harvard Pilgrim signs value-based contract with Illumina for noninvasive prenatal testing

Genetic and genomic sequencing companies are also doing their part in making personalized medicine more palatable to insurance companies by offering to pick up part of the tab.

Under a contract between Harvard Pilgrim Health Care and Illumina, Harvard Pilgrim will cover — to a predetermined limit — prenatal genetic testing for women under the age of 35 with average-risk pregnancies, while Illumina, a next-generation genetic testing company, will cover the remaining cost.

Partnerships like this may show the utility of genetic testing while potentially reducing the financial burden of lifelong healthcare for improperly diagnosed and treated conditions.

REGULATORY CHALLENGES

The development of PM begins with the identification of patient-specific features. This often consists of a screen for a biomarker that allows tailoring of a therapy for a subset of the people affected by the disease. The trend is now moving towards whole-genome sequencing to identify specific gene variants indicative of a particular disease, and then establishing a treatment program based upon that genetic profile.

The FDA has started to validate the analytical performance of presumed biomarkers of a disease.

However, whole-genome sequencing provides data on three billion base pairs, which is a lot of information about variants whose significance has been heretofore unknown. The FDA has encountered the problem of needing to establish that a potential biomarker identified from sequencing is analytically and clinically valid without knowing anything about the variants. To partially address this problem, the FDA has started to validate the analytical performance of these presumed biomarkers through extensive testing of the proposed function of the biomarker.

Another level of regulation associated with PM is a companion diagnostic. With PM, treatment strategies are often devised based on patient genetic profiling and assimilation of that profile with the drug target pathway. This means that **FDA approval is necessary not only for the therapeutic drug but also for the diagnostic indicator.**

What are the current challenges of personalized medicine?

ETHICAL & SOCIAL CONSIDERATIONS

Personalized medicine is possible thanks to the thousands of people who have essentially donated their medical information. Much of the data now stored in biobanks and used to make informed treatment decisions were gathered when PM was not but a thought. Potential ethical issues of using this data, where informed consent was given at a time when PM was inconceivable, have been resolved. The language of consent forms was broad and therefore ruled inclusive for modern research questions.

Overall, there is a lack of consistency in consent requirements and perhaps a need for more strict and pervasive health data protection legislation.

In the age of big data, the most important considerations surround patient confidentiality, protection, and ownership of information, and proper disposal of materials. While interdisciplinary collaboration is great for innovation and discovery, it can also confuse the proper channels for information and sample handling. To get a handle on this, patients now have the power to control their information through **dynamic consent** which requires communication between the patient and the user of the patient's information when the user plans to apply the data to a new project and permits the patient to deny or allow consent at any point and always be informed of how their information is to be used. **But dynamic consent is neither widespread nor a requirement across all biobanks.**

PERSONALIZED MEDICINE FOR CANCER

Examples of Success Stories of PM in Cancer Therapeutics

Historically, cancer was diagnosed and classified based on its origin (breast, lung, prostate, etc.) and clinical aggressiveness. The success of precision medicine has paved acceptance toward diagnosing and treating many cancers based on their receptor status and molecular profile.

The **prescreening of a patient's tumors for genes** such as HER2, BRAF V600E, and ALK before prescribing trastuzumab (breast cancer), vemurafenib (melanoma), and crizotinib (lung cancer), respectively, are some of the most well-known success stories where personalized medicine has been instrumental in the optimization of targeted treatments.

A more recent example has been the screening of microsatellite instability status for predicting sensitivity to checkpoint inhibitors which is now recognized to be a powerful predictor for a specific kind of immunotherapies.

In fact, in 2017 the FDA approved Keytruda (pembrolizumab), a checkpoint inhibitor, for the treatment of pediatric and solid tumors that have metastatic microsatellite instability-high (MSI-H) or mismatch repair deficient (dMMR) signatures and where prior therapy has been unsuccessful. **With the FDA calling this the "first tissue/site agnostic approval," cancer pundits hailed it as one of the biggest wins yet for personalized medicine and immunotherapy.**

Popular Cancer Diagnostic Products That Guide Precision Medicine

PreScouter documented **17 companies** who have developed cancer diagnostic products that guide PM. Below, a few examples are highlighted. The full list can be viewed **here** (p22).

Company	Popular Products/Services	Description
Abbott	Vysis CLL FISH Probe Kit	Detects deletion of the LSI TP53, LSI ATM, and LSI D13S319 and gain of the D12Z3 sequences by FISH in blood samples of B-cell chronic lymphocytic leukemia (CLL)
	Vysis ALK Break Apart FISH Probe Kit	Detects rearrangements involving the ALK gene via FISH technology in NSCLC tissue specimens
Caris Life Sciences	Caris Molecular Intelligence Comprehensive Tumor Profiling	Analysis of multiple biomolecules (DNA, RNA, and protein using IHC, FISH, and NGS, respectively) and pyrosequencing to generate reports that guide treatment decisions
Illumina	AmpliSeq for Illumina Comprehensive Cancer Panel	Multiple ready-to-use and custom sequencing-based panels for cancer research
	TruSight Oncology 500 Cancer Panel	Detects driver mutations that cause cancer
Genomic Health	OncotypeDX for breast, prostate, and colon cancer	21-gene test; one of the most widely used tools for guiding breast cancer treatment
Asurgen	QuantideX NGS DNA Hotspot 21 Kit	Subtype-specific (e.g., QuantideX NGS RNA Lung Cancer Kit and QuantideX qPCR BCR-ABL minor Kit) and pan-cancer NGS research tools that can screen up to 46 hotspot regions (amplicons) within 21 genes commonly altered in solid and hematological malignancies
Molecular Health	MH Guide	A computational platform that gathers evidence from medically and scientifically curated, peer-reviewed, and published sources. The data are then analyzed in the context of patient-specific (gender, tumor type, and variant data) and clinical information to generate a summary of treatment options, which are categorized based on their predicted efficacy and risk for adverse reactions

Cancer Immunotherapy

The evolution of biomedical research has introduced **immunotherapy** as a better, more targeted approach to treating cancer. Immunotherapies include monoclonal antibodies, immune checkpoint inhibitors, cytokines, cancer treatment vaccines, and cell-based therapies such as CAR T-cell therapy.

The overarching goal of cancer immunotherapy is to harness the immune system to specifically target and kill cancer cells while sparing healthy cells. Most current immunotherapies are designed to either target a specific tumor antigen or to enhance the patient's own immune system.

Monoclonal antibodies, the first type of immunotherapy to achieve widespread clinical use, have low cytotoxicity and target specific molecular moieties that tumor cells express.

➔ Trastuzumab (**Herceptin**) and pertuzumab (**Perjeta**) target HER2 breast cancer antigens and deliver improved clinical outcomes for patients with HER2-positive breast cancers.

➔ Other monoclonal antibodies, such as everolimus (**Afinitor**), are more clinically effective for HER2-negative breast cancer.

Personalized Cancer Vaccines

Aside from antibodies, cancer treatment vaccines leverage the power of a body's T-cell response to mounting a potent immunization response against specific tumor neoantigens, or antigens expressed exclusively by cancerous cells. Identification of patient-specific neoantigens has led to the development of personalized cancer vaccines for **late-stage melanoma** and for **breast, lung, and colon cancers**.

CAR T-cell therapy mentioned previously holds promise for individualized treatment because a patient's own T-cells are removed, re-engineered, and replaced with the precise ability to attack that patient's tumor cells.

CONCLUSION

In addition to these examples, a plethora of novel therapeutic modalities that take advantage of various aspects of the complex machinery of the immune system to enable ever more targeted cancer treatments is being developed. The continued advancement and modification of these technologies will help normalize the practice of tailored treatments not only for particular cancers but also for subtle patient-specific differences within a particular cancer type.

PERSONALIZED MEDICINE & REGENERATIVE MEDICINE

How is personalized medicine advancing the field of 3D printing?

One of the best examples of personalized medicine revolutionizing the field of regenerative medicine is the rapidly growing list of 3D-printed organs. Although the technology is relatively new and its clinical translation is not widespread, there have recently been measurable research advances that include 3D printing of [skin](#), [kidney](#), [heart](#), [heart valves](#), [ovaries](#), [eyes](#), [ears](#), [teeth](#), [prosthetics](#), and [bones](#) — just to name a few.

In April 2019, scientists from Tel Aviv University in Israel reported [3D printing of a cherry-sized heart](#) that captures the full spectrum of anatomical complexity of cells, blood vessels, ventricles, and chambers within this organ. Although the cells can contract, the physiological action of pumping still needs to be achieved. Nevertheless, the anatomical detail of the printed organ represents a major advance.

A more tangible advance of PM is evident through the success of Align Technology Inc., which recently reported multimillion-dollar sales of its [Invisalign](#) clear-aligner orthodontics. The company uses 50 to 60 3D printers to churn out more than eight million customized orthodontics annually — each made by taking a scan of the patient's oral cavity through their patented iTero system.

Custom 3D printing of bones has also been achieved. Dutch startup [Xilloc](#) synthesizes patient-specific 3D-printed bone implants, which integrate with the existing skeleton and are designed to fit perfectly based on a patient's CT scans.

How can personalized medicine eliminate the risk of tissue rejection?

Another powerful strategy involves the use of patient-derived stem cells to grow organoids — mini-organs that recapitulate the morphological and functional complexities of organs. Embryonic stem cells are an attractive option for tissue engineering because they can be manipulated into any type of cell in the body (i.e., they are pluripotent), whereas adult stem cells have limited differentiation capacity based on their tissue of origin.

In practice, researchers can regenerate skin using a patient's own cells. For example, a genetic and potentially lethal condition known as epidermolysis bullosa, characterized by dysfunctional laminin and collagen proteins, causes painful skin rupturing and blistering. But in a single-person clinical trial where a young boy's healthy skin cells were genetically reprogrammed and grafted onto his damaged skin, nearly 80% of his injured epidermis self-repaired.

The implications of this study are encouraging because it circumvented the colossal problem of tissue rejection associated with transplanting foreign tissue (e.g., receiving skin transplants from a different person). This **risk disappears** when a patient's own cells are used.

PERSONALIZED MEDICINE FOR DIABETES

Identification of Genetic Variants Linked to Type 2 Diabetes

Diabetes affects more than [425 million people](#) worldwide. Identifying risk factors at the outset and preventing the disease is the key to reducing the global diabetes burden. Precision medicine advances will be instrumental in identifying demographic markers that can predict the risk of developing the disease.

But how does one accurately predict the risk for a disease which is notoriously common?

Researchers from Massachusetts General Hospital and the Broad Institute of MIT and Harvard have attempted this by analyzing genomic data for over 94 genetic variants already associated with type 2 diabetes. Using computational biology models and biostatistics, the team identified **[five DNA sites](#)** within the genome, each of which leads to the disease through discrete mechanisms that include insulin resistance, obesity, disrupted hepatic metabolism of fats in the liver, distribution of fat within the body, or beta-cell dysfunction.

Personalized medicine approaches like these could be instrumental in early identification of genetic signatures that increase a person's risk of developing diabetes and in guiding the adoption of lifestyle changes based on this profile.

The Significance of Studying Both Genetic & Environmental Factors

However, while genetic studies may yield some insight into diabetes development, this disease is multifactorial and is as much caused by genetic as by nongenetic factors.

Big data and machine learning can help integrate genetic predisposition with more phenotypic criteria such as age, weight, blood glucose, and comorbidities to accurately cluster patients into subgroups for personalized clinical treatment.

The combination of a patient-specific understanding of both genetic and environmental factors will radically improve our ability to predict which individuals are at the highest risk of developing the disease.

PERSONALIZED MEDICINE FOR CARDIOVASCULAR DISEASES

Precision Medicine Holds Promise for Cardiovascular Disease

Considerable research has been done on individual genomic profiling of specific genes that can guide cardiologists in matching treatment with the type of cardiac pathology. Examples of such genes include KCNQ1, KCNH2, and SCN5A. These genes code for channels that determine ion balance across cardiac cells and have been used to predict which beta-blockers are useful for different subtypes of Long-QT syndrome, a type of arrhythmia that can lead to sudden cardiac arrest.

MyoKardia, a clinical-stage biopharmaceutical company, uses PM approaches to identify targeted therapies for the treatment of serious and rare cardiovascular diseases. The company recently entered into a partnership with 23andMe to develop a digital platform for hypertrophic cardiomyopathy patients with the aim of identifying genetic and environmental determinants that lead to the development of this disease.

Pharmacogenomic assays that can predict the efficacy of lipid-lowering drugs (such as statins) are another example of a high-potential application of PM in the cardiovascular field. The indiscriminate use of statins in patients with high cardiovascular risks and their undesirable side effects are causes of concern, and their use is hotly debated among cardiologists. Many cardiologists have expressed a need for technologies that can guide the use of statins in patients.

Answering this call, Genomas, a small Connecticut-based company, has developed SINM PhyzioType, a genome array that can predict the efficacy and side effects of lipid-lowering drugs such as atorvastatin, simvastatin, and rosuvastatin in patients based on their genetics.

Owlstone & Thermo Fisher team up for early disease detection

Owlstone Medical has announced a new collaboration with Thermo Fisher Scientific, in order to advance early disease detection using the company's non-invasive breath biopsy technology.

The new partnership seeks to advance the application of non-invasive breath sampling to "address the challenges of the early detection of disease and the precision medicine delivery of healthcare through the discovery and validation of novel biomarkers."

If successful, the technology will then become a standard part of Owlstone Medical's biomarker discovery process, whereby metabolomic studies are conducted on breath samples for internal programs to discover novel biomarkers that could translate into research and clinical tests.

PERSONALIZED MEDICINE FOR HIV

Precision Medicine Advances in HIV

According to the World Health Organization, HIV remains one of the most pressing health problems today, with the disease claiming the lives of more than 940,000 people in 2017 and affecting greater than 36 million people worldwide.

Researchers are working to identify genetic determinants that could enable them to develop **targeted therapies** for this disease. PM advances that enable tailoring of cancer immunotherapies could also be a solution for tackling HIV.

Researchers from Penn Medicine, the Albert Einstein College of Medicine, and Sangamo BioSciences demonstrated the [applicability of personalized medicine in HIV treatment](#) recently in Phase 1 clinical trial. The researchers used zinc finger nucleases (specific molecular scissors that can remove a piece of DNA) to individually engineer T-cells of 12 patients by introducing a [CCR5-delta-32 mutation](#), which deletes the CCR5 gene that encodes a protein critical for viral entry into the cell. This is a change that naturally confers resistance to HIV but is not found in 99% of the population.

➔ When the engineered T-cells were reinfused back into the patients, they conferred **remarkable resistance to HIV** and persisted in the circulation of patients, keeping the burden low for several weeks.

➔ Half the patients were able to **discontinue antiretroviral therapy** for up to 12 weeks after starting the T-cell infusion.

Precision Medicine Advances in HIV

Antiretroviral therapy is typically the first line of defense against HIV. But prolonged therapy leads to drug resistance in some (but not all) HIV patients. This disparity in response to antiretroviral treatment has created a burgeoning pharmacogenomic approach to personalized medicine.

Drug resistance testing, including commercially-available kits such as **ViroSeq** and **HIV-1 Genotype**, use gene sequencing techniques to identify drug resistance mutations in HIV patients. The FDA recommends that HIV patients take the HLA-B*5701 allele test to narrow the list of potentially effective antiretrovirals. HLA-B*5701 is a variation of the human leukocyte antigen (HLA) complex, and people with this particular mutation are hypersensitive to the antiretroviral drug abacavir.

Aside from gene sequencing to evaluate appropriate antiretroviral drugs, online therapy prediction engines like the HIV Resistance Response Database Initiative personalize treatment strategies by synthesizing data gathered from various therapy options and ranking the best possible treatment combinations. This tool can estimate the outcomes of various drug interactions as well as the probability of developing viral resistance to specific antiretroviral combinations.

Still, in development, prediction engines could be a vital source of therapeutic information in the future, following extensive data integration pertaining to strains and mutations of HIV, metabolism of antiretrovirals, and patient adherence to therapy programs.

PERSONALIZED MEDICINE FOR ALZHEIMER'S DISEASE

How Much Promise Does Precision Medicine Hold for Alzheimer's?

Over the years, scientists have identified certain genetic variants expressed by different subpopulations of Alzheimer's patients that make them susceptible to the disease.

These genes serve as a focal point for the creation of drugs that directly target the genes or their downstream effectors. Genomic sequencing allows researchers and doctors to determine if patients express the same genes that their drugs target; if they do, they can readily recommend these drugs for treatment.

The Alzheimer's drug Anavex 2-73 has produced promising results in an initial Phase 2 clinical trial, which involved first sequencing potential participants' genomes and then assigning them to the trial if their genetic makeup and the mechanistic pathway of Anavex 2-73 coincided. While some may consider this method questionable, others argue that the heterogeneity of factors causing Alzheimer's demands that different drugs are administered to different people in order to produce the best possible outcomes.

A whole-genome analysis is the first step in identifying unique biomarkers enriched in afflicted populations. From there, pharmacogenomic drug testing provides a platform to measure the efficacy of specific drugs for individualized populations.

CONCLUSION

Where is the industry headed?

The industry has long recognized the promise of personalized medicine, with many new entrants in the last decade leading the way and offering molecular diagnostic services and comprehensive genomic testing for cancer and other diseases.

Forecasts of the total size of the personalized medicine market in 2025 range from [$100 billion USD](#) to over [$2 trillion](#), due to varying definitions of the market, with most research firms estimating a CAGR of 10–11% over that time period.

A robust ecosystem of companies working in this space is emerging which includes key players from the biopharmaceutical and high-tech industries (seen on next slide).

Figure: Key Players in the Personalized Medicine Ecosystem

Notable Partnerships & Collaborations

Drug giant **Pfizer** is making waves in the PM field through its development of cancer drugs like **Talzenna** (talazoparib), which in 2019 received approval from the European Commission as a therapeutic for breast cancer. Talzenna is a poly ADP-ribose polymerase (PARP) inhibitor administered orally for women with mutations in the germline breast cancer susceptibility gene (gBRCA)1/2.

Pfizer also currently has over 30 cancer drugs in clinical development, and in 2018, the company formed a [partnership](#) with Foundation Medicine to use FoundationOne CDx, a pan-cancer companion diagnostic, to advance the use of personalized medicine in patient care.

Oncology Pipeline Snapshot as of October 29, 2019

Discovery Projects	Phase 1	Phase 2	Phase 3	Registration	Total
	14	12	12	4	42

Source: [Pfizer](#)

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Notable Partnerships & Collaborations

On June 18, 2019 pharmaceutical company **Sanofi** announced [an alliance](#) with **Google**. Together, these two industry-leading companies are developing a virtual Innovation Lab that combines Google's deep data analytics, cloud computing, and AI with Sanofi's real-world scientific data to deliver individual patient-driven precision treatments.

Moreover, in a commendable effort to identify every genetic source contributing to cancerous cells, GlaxoSmithKline, Wellcome Sanger Institute, the European Bioinformatics Institute, and Open Targets have formed a [research collaboration](#) to use CRISPR technology to edit nearly 20,000 genes in 300 cancer models from 30 different cancer types. This effort **unveiled approximately 600 cancer genes** with uncharted therapeutic potential and formed the basis for the Cancer Dependency Map that pinpoints genetic targets for the precision treatment of cancer. These types of collaborations bode well for the future of the individualized approach to healthcare. PM stands on the pillars of "omics-based" testing, bioinformatics and AI, and perhaps most importantly, a collaboration between pharmaceutical/biotech companies, healthcare facilities, patients, and insurance companies.

> **The potential for PM to revolutionize drug delivery and patient care demands an evolutionary shift from the current modus operandi. The cost of omics-based testing decreases each year, and AI algorithms become sharper and more predictive with each new integrated data set. These changes mean increased affordability for tests that drive individualized patient treatment options.**

Atrium Innovations acquires personalized medicine platform LivingMatrix.

Atrium Innovations, a Nestle Health Science company, to further scale the future of personalized nutrition with the acquisition of LivingMatrix™.

Atrium Innovations takes the next step in the company's mission to expand into personalized nutrition with the acquisition of San Francisco-based LivingMatrix™. LivingMatrix, a technology-based, data and algorithm-driven personalized functional medicine platform, was designed by clinicians to help practitioners effectively evaluate and engage patients, create personalized, actionable care plans and track patient health outcomes.

"Our goal is to further scale our personalization platform through integrating LivingMatrix™ with our existing PureGenomics platform and future healthcare provider patient management systems providing the most comprehensive solution in the industry," says Kyle Bliffert, President of Atrium Innovations

What's Next for Healthcare & PM?

What remains to be seen is:

- How will these advancements influence clinicians' diagnostic and treatment decisions and whether all healthcare facilities will standardize personalized medicine practices?
- How will patient data be made available across all healthcare facilities so the most up-to-date information informs the ideal treatment strategy per patient?
- Will insurance companies follow in the footsteps of Harvard Pilgrim Health Care and cover a percentage of genetic and genomics testing, and later, personalized drug development?

As is the case with most scientific advancements, the regulatory, social, and economic facets must play catch-up with the technology. Clear and transparent processes and communication will be necessary to ensure that personalized medicine is practiced efficiently and effectively. With the power to address unmet medical needs at the individual level, universal personalized medicine is the goal.

As industry leaders sharpen their precision medicine technologies, and scientists and clinicians, along with healthcare, regulatory, and legislative bodies worldwide work tirelessly to streamline our arsenal of personalized medicine, we can be assured of a future that will bring unprecedented precision in identifying the "Right Treatment, Right Patient, Right Time."

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Next Steps

SOME POSSIBILITIES THAT PRESCOUTER CAN OFFER FOR CONTINUATION OF OUR RELATIONSHIP

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