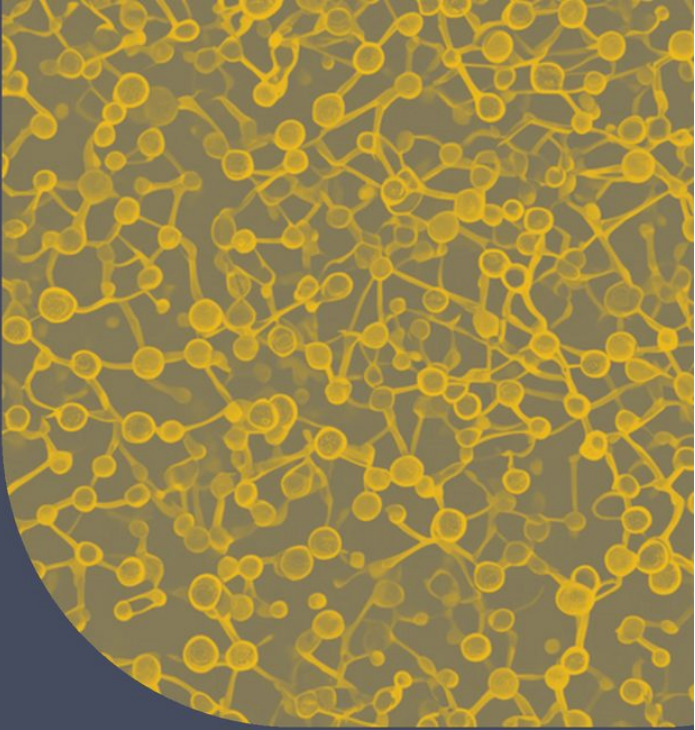




JULY 2024

Precision Medicine

Harnessing Automation & AI
for Transformative
Oncology Care

PRESENTED BY

inite
Innovation for life science

Table of Contents

03

Introduction

04

Problem Definition

05

Precision Medicine:
A Background

07

Precision Medicine
& Oncology

09

Automation & AI in
Precision Medicine

10

Intelligent Integration
of Technologies

14

Key Insights

15

Call to Action

INTRODUCTION

Welcome to the intersection of latest technologies and precision medicine.

We know that the future of cancer treatments will be smarter, faster and more precise to the specific person and case. But do we know how?

You may be wondering about how precision medicine, or personalized medicine, functions or how it relates to automation trends or the latest boom of AI technology.

In this whitepaper, we would like to give you a big picture overview of precision medicine efforts towards cancer research and **how the latest technologies contribute to the overall development of more personalized treatments.**

Our Goal

Provide a clear view of how **precision medicine**, with a little help from automation and AI, **can tackle the biggest challenges in cancer treatment** and **make it significantly more personalized and effective.**

PROBLEM DEFINITION

CHALLENGES WITH CANCER RESEARCH

Three major challenges impact patient outcomes and the overall efficiency of healthcare systems for cancer research and treatments.

High Costs: Developing and delivering cancer therapies isn't cheap and the costs can be astronomical. This burdens both patients and healthcare systems. Long-term cancer care with all its diagnostics, treatments and follow-ups has the risk to seriously strain resources.

Inefficiencies: Traditional cancer treatments often take a one-size-fits-all approach. This can lead to inefficiencies where different patients respond in drastically different ways to the same treatment. This leads to longer and less predictable treatment times. It also leads to higher healthcare costs.

Lack of Personalized Treatments: Many cancer treatments fail to consider the unique genetic and molecular profiles of individual tumors and patients. This lack of personalization can result in less effective treatments. Unwanted side effects are common in the currently available methods.

This makes precision medicine
a prime area of development for cancer research.

Reducing Healthcare Costs

Optimizing resources and reducing trial-and-error can help cut down the overall costs of cancer treatment, as well as the duration.

Advancing Cancer Research

Precision medicine helps understanding cancer mechanisms, leading to the development of more effective and targeted therapies.

Improving Patient Outcomes

Personalized treatment strategies are more effective, reduce debilitating side effects and improve overall patient outcomes.

More directly, Precision Medicine enables:

Personalizing Treatment Plans

Tailoring treatments based on genetic, environmental and lifestyle factors, it aims to optimize outcomes by creating targeted therapies. These treatments better and come with fewer side effects for the patients.

Predicting Treatment Responses

Using AI and predictive analytics, it helps forecast how patients will respond. This assists in picking the most suitable treatment and reduces time wasted in crucial circumstances, boosting the overall efficiency of patient care.

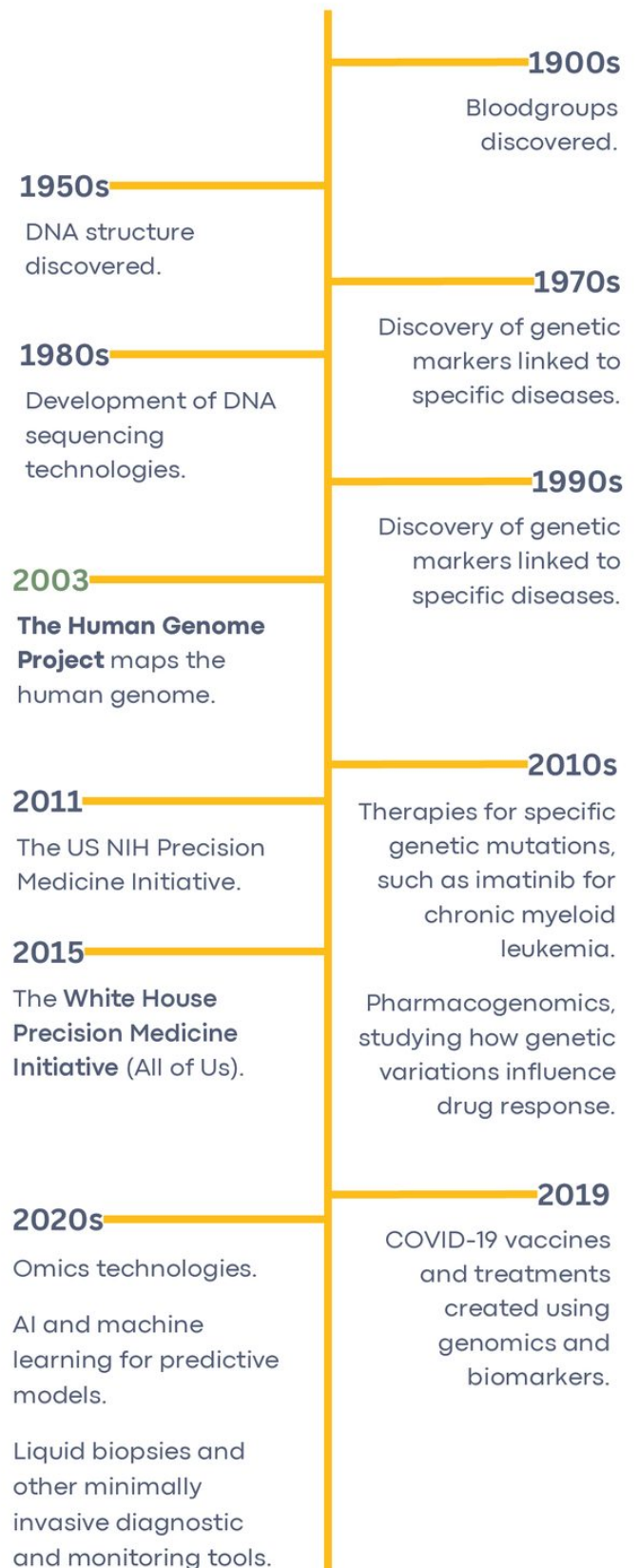
Precision Medicine is about treating the person and not just the disease:
Making cancer treatment smarter, faster and a whole lot more personal.

QUICK HISTORY OF PRECISION MEDICINE

Precision medicine, also known as personalized medicine, tailors medical treatment to individual characteristics of each patient.

The concept of precision medicine has been around for decades. It gained significant momentum with the completion of the Human Genome Project in 2003, which successfully mapped the entire human genome. It provided unprecedented insights into genetic variations and their roles in health and diseases. The recent developments in high-throughput sequencing technologies and bioinformatics tools, which allow for more detailed genetic analysis and personalized treatment plans, further accelerated the field.

The future of precision medicine holds immense potential. Continued advancements in technology, coupled with a focus on patient engagement and collaboration, will drive further breakthroughs and improve patient outcomes in an ever-increasing speed.



PRECISION MEDICINE: A BACKGROUND

STATUS QUO IN PRECISION MEDICINE

Precision medicine is increasingly integrated into healthcare systems worldwide.

It is particularly prominent in oncology where genetic profiling of tumors allows for tailored treatment strategies that improve patient outcomes and minimize adverse effects.

Targeted Therapies: Development of drugs that target specific genetic mutations, such as HER2 inhibitors in breast cancer and BRAF inhibitors in melanoma.

Immunotherapy: Harnessing the patient's immune system to fight cancer, guided by genetic markers.

Pharmacogenomics: Using genetic information to predict drug responses and tailor prescriptions accordingly.

Companion Diagnostics: Diagnostic tests designed to identify patients likely to benefit from specific treatments.

Despite these advancements there are still challenges to overcome, such as data integration and security, standardization of genetic testing and ensuring equitable access to precision medicine. Enabling technologies help with this.

A FEW ENABLING TECHNOLOGIES



Imaging Technologies

Technologies such as MRI and PET are frequently used for precision medicine to diagnose.



Genomics & Bioinformatics

Sequencing and genome analysis are used to understand the genetic profile of the disease to be targeted.



Automation

Robotics and automated systems streamline laboratory processes, from sample preparation to data analysis, enhancing efficiency and accuracy.



AI & Machine Learning

AI algorithms and Machine Learning models allow analyzing 'big' clinical data, identifying patterns and predicting outcomes to help personalized treatment.



Quantum Computing

Quantum computing performs computations at previously unachieved speed, which helps with data analysis and simulation in precision medicine.

Why is it crucial to utilize precision medicine in cancer research?

Precision medicine has emerged as a transformative approach in oncology, fundamentally altering how cancer is diagnosed, treated and managed.

Its significance lies in several key areas.

1

ADVANCED DIAGNOSTICS & EARLY DETECTION

Tools like next generation sequencing and liquid biopsies, cancer can be detected at earlier stages with the necessary information on the genetic variation. This provides effective intervention strategies in the treatment of the early phases of cancer.

2

PERSONALIZED TREATMENT PLANS

Traditional cancer treatments often adopt one-size-fits-all approach which is ineffective and leads to severe side effects. Precision medicine tailors treatment to the genetic profile of the individual patient's tumor. This personalization increases the likelihood of treatment success and minimizes adverse reactions.

3

TARGETED THERAPIES

Precision medicine enables the development of therapies which focus on specific genetic mutations driving cancer growth. These therapies are more effective and less harmful, such as in the case of tyrosine kinase inhibitors for chronic myeloid leukemia and HER2 inhibitors for certain breast cancers.

4

IMPROVED CLINICAL OUTCOMES

Patients receive therapies that are more likely to be effective for their specific cancer type. This allows improvements such as higher response rates, longer survival times and better quality of life.

Case Studies

TARGETED THERAPY FOR LUNG CANCER

A patient with non-small cell lung cancer had few options for regular chemotherapy and these treatments caused severe side effects. When they were discovered to have an epidermal growth factor receptor (EGFR) gene mutation they were treated specifically with an EGFR inhibitor called gefitinib (Iressa). **This targeted treatment resulted in tumor regression in many patients.**

Paez, J. G., et al. (2004). EGFR Mutations in Lung Cancer: Correlation with Clinical Response to Gefitinib Therapy. Science, 304(5676), 1497-1500.

BREAST CANCER AND HER2 INHIBITORS

HER2-positive breast cancer patients have benefited immensely from the development of targeted therapies like trastuzumab (Herceptin). This antibody specifically targets the HER2 protein, which promotes the growth of cancer cells. Clinical trials and real-world data show that trastuzumab, combined with chemotherapy, **significantly improves survival rates in HER2-positive breast cancer patients.**

Slamon, D. J., et al. (2001). Use of Chemotherapy Plus a Monoclonal Antibody Against HER2 for Metastatic Breast Cancer that Overexpresses HER2. New England Journal of Medicine, 344(11), 783-792.

MELANOMA AND BRAF INHIBITORS

The identification of BRAF mutations in melanoma has led to the development of BRAF inhibitors such as vemurafenib (Zelboraf). In patients with BRAF-mutant melanoma vemurafenib **has shown remarkable efficacy, resulting in significant tumor regression and improved survival rates.**

Chapman, P. B., et al. (2011). Improved Survival with Vemurafenib in Melanoma with BRAF V600E Mutation. New England Journal of Medicine, 364(26), 2507-2516.

CHRONIC MYELOID LEUKEMIA (CML)

The introduction of imatinib (Gleevec), an inhibitor targeting the BCR-ABL fusion protein, has transformed CML from a fatal disease to a manageable chronic condition. **Long-term studies show that most patients treated with imatinib achieve sustained remissions.**

Druker, B. J., et al. (2006). Five-Year Follow-Up of Patients Receiving Imatinib for Chronic Myeloid Leukemia. New England Journal of Medicine, 355(23), 2408-2417.

ACUTE LYMPHOBLASTIC LEUKEMIA (ALL)

CAR-T therapy involves modifying a patient's T cells to target cancer cells, providing a personalized and highly effective treatment. **Use of CAR-T cell therapy in patients with ALL have led to unprecedented remission rates in relapsed or refractory ALL patients.**

Maude, S. L., et al. (2014). Chimeric Antigen Receptor T Cells for Sustained Remissions in Leukemia. New England Journal of Medicine, 371(16), 1507-1517.

How can AI help with personalized treatments?

ENHANCED DISCOVERY & DEVELOPMENT OF DRUGS

AI can analyze genomic, proteomic and clinical information to uncover patterns and predict effective molecules for treatment. This reduces the time and cost of trial-and-error.

STREAMLINED RESEARCH & LAB WORKFLOWS

Automation accelerates laboratory workflows and experimental procedures while AI helps with the design of experiments, drug discovery and the interpretation of complex biological data. This collective advantage speeds up the development of new cancer therapies and their translation into clinical practice.

DATA INTEGRATION & MANAGEMENT

Precision medicine relies on vast amounts of data from genomic sequencing, clinical records and patient histories. Automated tools make it easier to gather, keep and work with huge amounts of patient info. This includes genetic data, health records and how well treatments work as well as complex analysis of these data for identifying patterns. AI enables identification of these key trends and findings and helps analyze the data to uncover patterns, predict treatment responses and suggest personalized treatment plans.

IMPROVED DIAGNOSTIC ACCURACY

Technological applications such as robotics and advanced imaging systems ensure greater accuracy in diagnostic procedures. AI-powered diagnostic tools analyze imaging and pathological data, detecting cancer cells and genetic mutations more accurately than traditional diagnostic methods

PREDICTIVE ANALYTICS

AI algorithms look at big sets of data to spot patterns and identify potentially receptive patients. This helps doctors see how the disease might progress, customize treatment plans and get better results for patients.

PERSONALIZED TREATMENT PLANS

AI-driven tools can use a variety of data sources to generate personalized treatment recommendations. Machine learning models can analyze the effectiveness of therapies based on the patient's unique genetic profile, leading to more targeted and effective treatments, improving the chance of success.

Relating advancements in Precision Medicine to Automation & AI

Precision medicine, automation & AI together provide the ability to deliver personalized cancer treatments more efficiently and effectively.

We have gathered some examples of this phenomenon.

IBM WATSON FOR ONCOLOGY & MANIPAL HOSPITALS

IBM Watson for Oncology uses natural language processing and machine learning to analyze patient data and provide evidence-based treatment recommendations. Watson's ability to rapidly process and interpret medical literature helps oncologists make informed decisions tailored to individual patients.

At Manipal Hospitals in India, Watson for Oncology was used to assist in treatment planning for over 1,000 cancer patients. The system's recommendations were found to be consistent with expert oncologists' decisions in 93% of cases, demonstrating its potential to enhance clinical practice.

BM Watson Health. (2017). IBM Watson for Oncology: A Cognitive Computing System to Transform Cancer Care.

DEEPMIND HEALTH & MOORFIELDS EYE HOSPITAL

DeepMind, a subsidiary of Alphabet Inc., collaborated with Moorfields Eye Hospital to develop AI algorithms for early detection of eye diseases. The same AI techniques are being adapted for oncology to analyze medical images and identify cancerous lesions with high accuracy.

The AI system was trained on thousands of retinal scans and successfully detected signs of diabetic retinopathy and age-related macular degeneration. This technology is being expanded to analyze pathology slides and radiology images for cancer diagnosis.

De Fauw, J., et al. (2018). Clinically Applicable Deep Learning for Diagnosis and Referral in Retinal Disease. *Nature Medicine*, 24(9), 1342-1350.

MATCHING CLINICAL AND GENOMIC DATA AT TEMPUS

Tempus uses AI and machine learning to analyze clinical and molecular data, enabling personalized cancer treatment. Their platform integrates genomic sequencing, clinical data and imaging to provide actionable insights for oncologists to analyze the genetic data to identify actionable mutations.

In a study involving patients with metastatic breast cancer, Tempus' AI-driven analysis provided comprehensive genomic profiles and treatment recommendations within days and identified novel treatment options that led to significant improvements in patient outcomes.

Tempus. (2020). Tempus: Using AI to Power Precision Medicine.
Tempus. (2020). Harnessing Data and AI to Revolutionize Precision Medicine

AI IN RADIOLOGY AT STANFORD UNIVERSITY

Researchers at Stanford University developed CheXNet, a deep learning algorithm for detecting pneumonia and other diseases in chest X-rays. This technology is being adapted to identify various types of cancer, including lung cancer.

CheXNet was trained on a dataset of over 100,000 chest X-rays and achieved performance comparable to expert radiologists. Its application in oncology promises to enhance early detection and diagnosis of lung cancer.

Rajpurkar, P., et al. (2017). CheXNet: Radiologist-Level Pneumonia Detection on Chest X-Rays with Deep Learning. *arXiv preprint arXiv:1711.05225*.

Relating advancements in Precision Medicine to Automation & AI

AI-DRIVEN DIAGNOSTIC TOOLS AT MSK CANCER CENTER

Memorial Sloan Kettering Cancer Center partnered with IBM Watson to develop AI-driven diagnostic tools. These tools analyze medical images and pathology reports to identify cancerous lesions and predict disease progression.

The AI system was tested on a dataset of thousands of mammograms and pathology slides. It achieved diagnostic accuracy comparable to expert radiologists and pathologists, significantly reducing the time required for diagnosis and treatment planning.

McBee, M. P., et al. (2018). Deep Learning in Radiology. *Academic Radiology*, 25(11), 1472-1480.

ROBOTICS & AI IN SURGERY AT MAYO CLINIC

Mayo Clinic has integrated robotics and AI into surgical oncology. Robotic systems provide precise control during surgery while AI algorithms assist in preoperative planning and intraoperative decision-making.

In cases of prostate cancer, robotic-assisted surgeries guided by AI analysis of preoperative imaging resulted in improved surgical outcomes, including reduced operative times, lower complication rates and faster patient recovery.

Atallah, S., et al. (2017). Robotic Surgery: Current Applications and Future Directions. *International Journal of Medical Robotics and Computer Assisted Surgery*, 13(4), e1884. Tempus. (2020). Harnessing Data and AI to Revolutionize Precision Medicine

PATHAI & PATHOLOGY ANALYSIS

PathAI uses AI algorithms to analyze pathology images, improving the accuracy and consistency of cancer diagnoses. Their technology assists pathologists by highlighting areas of concern and providing quantitative data on tumor characteristics.

PathAI's platform was validated through clinical trials, demonstrating higher diagnostic accuracy compared to traditional methods. It significantly reduced interobserver variability, leading to more consistent and reliable pathology reports.

Campanella, G., et al. (2019). Clinical-grade Computational Pathology Using Weakly Supervised Deep Learning on Whole Slide Images. *Nature Medicine*, 25(8), 1301-1309.

AI IN CLINICAL TRIALS

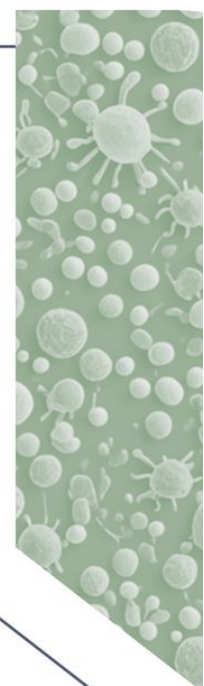
Utilizing AI accelerates clinical trials by identifying suitable candidates, optimizing trial designs and predicting patient responses. By analyzing historical trial data and real-world evidence AI models can enhance patient recruitment and retention, reducing trial duration and costs.

Weng, C., et al. (2019). Improving Patient Selection for Clinical Trials: Leveraging Electronic Health Records with AI. *Journal of the American Medical Informatics Association*, 26(9), 938-944.

PREDICTIVE MODELING

AI models predict disease progression, treatment outcomes and potential complications by analyzing complex datasets. These predictions help clinicians make proactive decisions, improve patient management and tailor treatments to individual needs.

Topol, E. J. (2019). High-Performance Medicine: The Convergence of Human and Artificial Intelligence. *Nature Medicine*, 25(1), 44-56.



Relating advancements in Precision Medicine to Automation & AI

AI-POWERED DRUG DEVELOPMENT

AI can be used to predict the efficacy and safety of new drug compounds, reducing the time and cost of drug development. By simulating interactions between drugs and cancer cells, AI accelerates the discovery of novel therapies.

Zhavoronkov, A., et al. (2019). Artificial Intelligence in Drug Discovery and Development. *Journal of Medicine and Chemistry*, 62(21), 9827-9840.

PERSONALIZED VACCINES AND IMMUNOTHERAPIES

Combining genomic data with AI-driven analysis can lead to the development of personalized cancer vaccines and immunotherapies. These treatments are tailored to the unique genetic profile of each patient's tumor, enhancing their effectiveness.

Finn, O. J. (2018). Personalized Cancer Vaccines: The Road Ahead. *Translational Cancer Research*, 7(Suppl 3), S258-S265.

PATIENT DATA ANALYSIS

AI-powered platforms aggregate and analyze patient data from various sources, including electronic health records (EHRs), genomic data and wearable devices. This holistic analysis provides a comprehensive view of patient health, enabling more accurate diagnoses and personalized treatment plans.

Esteva, A., et al. (2019). A Guide to Deep Learning in Healthcare. *Nature Medicine*, 25(1), 24-29.

REAL-TIME MONITORING AND ADAPTIVE TREATMENT

Wearable devices and remote monitoring systems can continuously collect patient data, which AI algorithms analyze in real time. This enables adaptive treatment strategies that respond dynamically to changes in a patient's condition.

Topol, E. J. (2019). High-Performance Medicine: The Convergence of Human and Artificial Intelligence. *Nature Medicine*, 25(1), 44-56.

PREDICTIVE MAINTENANCE FOR ONCOLOGY EQUIPMENT

AI can predict when oncology equipment, such as radiotherapy machines, will require maintenance, minimizing downtime and ensuring that patients receive uninterrupted treatment.

Escobar, L. A., & Meeker, W. Q. (2006). A Review of Reliability Models for Mechanical Systems. *Quality and Reliability Engineering International*, 22(8), 803-834.

PAN-CANCER ANALYSIS OF WHOLE GENOMES (PCAWG)

The Cancer Genome Atlas (TCGA) project provided genomic, transcriptomic and epigenomic data across various cancer types. By integrating these multiomic datasets, researchers could identify novel genetic mutations and molecular pathways that drive cancer progression.

The Cancer Genome Atlas (TCGA)

THE CANCER GENOME ATLAS PROGRAM (TCGA)

The Pan-Cancer Analysis of Whole Genomes (PCAWG) consortium performed an extensive multiomic analysis across 2,658 cancer whole genomes, encompassing over 30 types of cancer. The study aimed to uncover universal cancer-driving mechanisms and tumor-specific vulnerabilities.

The ICGC/TCGA Pan-Cancer Analysis of Whole Genomes Consortium. Pan-cancer analysis of whole genomes. *Nature* 578, 82-93 (2020). <https://doi.org/10.1038/s41586-020-1969-6>

MULTIOMICS FOR TARGETED TREATMENTS

ASTRAZENECA'S ONCOLOGY RESEARCH

AstraZeneca employed a multiomics strategy combining genomics, transcriptomics and proteomics to identify novel therapeutic targets for non-small cell lung cancer (NSCLC). This integrated approach revealed critical biomarkers and molecular pathways that were previously unrecognized, leading to the development of osimertinib (Tagrisso), a targeted therapy for EGFR-mutated NSCLC. The use of multiomics significantly accelerated the drug discovery process and enhanced the precision of targeting specific cancer mutations.

[New era of multi-omic data analysis in oncology. AstraZeneca, 2023.](#)

DRUG RESISTANCE & REPURPOSING: PFIZER, NOVARTIS

Companies like Pfizer, Merck and Novartis utilize multiomics approaches, integrating genomics, transcriptomics and proteomics, to identify novel targets for cancer therapy. They work on small-molecule drugs that act on a variety of RNA targets.

By analyzing the multi-layered data from tumor samples, researchers at Pfizer discovered key biomarkers and molecular pathways implicated in drug resistance, which allows them to develop a new class of targeted therapies aimed at these specific pathways, significantly improving treatment outcomes for patients with resistant forms of cancer. It further provided deeper insights into tumor biology, leading to more effective drug development.

Novartis employed a multiomics strategy to repurpose an anti-inflammatory drug for a subtype of breast cancer. This approach enabled the identification of novel therapeutic targets, facilitating the repositioning of an existing drug to treat breast cancer effectively. This case study demonstrates the efficiency and cost-effectiveness of multiomics in finding new uses for existing drugs.

Mullard, A. Small molecules against RNA targets attract big backers. Nat Rev Drug Discovery

DRUG REPURPOSING AT BRISTOL-MYERS SQUIBB

Bristol-Myers Squibb utilized multiomics data to repurpose an existing immunotherapy drug for a new indication in melanoma treatment. By integrating genomic, epigenomic and proteomic data, the researchers identified new pathways and biomarkers that the immunotherapy could target. This led to the successful application of nivolumab (Opdivo) in treating advanced melanoma, showcasing the potential of multiomics in uncovering novel therapeutic uses for established drugs and accelerating the path to clinical application.

Nivolumab: OPDYTA® , <https://www.bms.com/>

MULTIOMICS IN PERSONALIZED CANCER MEDICINE AT ROCHE

Roche applied multiomics technologies to develop personalized cancer treatments, focusing on integrating genomic, proteomic and metabolomic profiles from patient samples. This comprehensive approach enabled the identification of unique molecular signatures that could predict individual responses to specific therapies. One notable success was the development of a personalized treatment regimen for patients with metastatic colorectal cancer, which significantly improved response rates and survival outcomes. By tailoring therapies to the molecular characteristics of each patient's tumor, Roche demonstrated the potential of multiomics to enhance precision medicine in oncology, leading to more effective and personalized treatment options.

The frontrunner in personalised healthcare, Roche, 2024

Precision Medicine Summary

Critical Role in Oncology

Precision medicine allows for personalized treatment plans that consider individual genetic and molecular profiles, leading to more effective and less harmful cancer therapies.

Integration of Automation and AI

Automation and AI enhance precision medicine by streamlining experiment and data management, improving predictive analytics and enabling personalized treatment plans. These technologies are crucial in handling the complexity and volume of data required for effective precision medicine.

Real-World Impact

Case studies from leading pharmaceutical companies and research groups demonstrate how multiomics approaches, enabled by automation and AI, have led to significant advancements in drug discovery, repurposing and personalizing treatment plans.

Future Prospects

The integration of the right technologies lead to greater innovations in oncology, from more accurate predictive models to faster and more cost-effective drug development.

Precision Medicine at Inite

Our journey in precision medicine is marked by a series of successful collaborations with leading pharmaceutical companies and lab tech providers. We have partnered with renowned organizations to advance their research and development efforts, streamline their laboratory processes and enhance their data analytics capabilities. This extensive experience has given us a profound understanding of the complexities and nuances of precision medicine in oncology.

We invite you to explore how our expertise in precision medicine, automation and AI as we can help you transform your oncology research and treatment efforts. Whether you're starting a new project or looking to enhance your current initiatives, we offer the knowledge, tools, and experience to help you achieve your goals.

Our Expertise

Lab Automation: We specialize in implementing state-of-the-art automation technologies that enhance efficiency and accuracy in laboratory settings. Our solutions reduce manual errors, increase throughput, and optimize workflow processes.

Multimomics Applications: Our proficiency in integrating genomics, proteomics, transcriptomics and metabolomics data enables us to provide holistic insights into cancer biology. This integration is crucial for identifying novel therapeutic targets and developing personalized treatment plans.

Change Management: We assist organizations in navigating the complexities of adopting new technologies and methodologies. Our change management strategies ensure seamless transitions and maximize the benefits of digital transformation.

Digital Adoption: We help our clients leverage digital tools and platforms to improve data management, analysis and interpretation. Our expertise in AI and machine learning drives innovative solutions that enhance precision medicine's impact on oncology.



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MAKE A LASTING IMPACT ON PATIENT CARE

