

PERSONALIZED MEDICINE, TARGETED THERAPEUTICS & COMPANION DIAGNOSTIC MARKET

A STRATEGIC ANALYSIS OF
INDUSTRY TRENDS, TECHNOLOGIES,
PARTICIPANTS & ENVIRONMENT

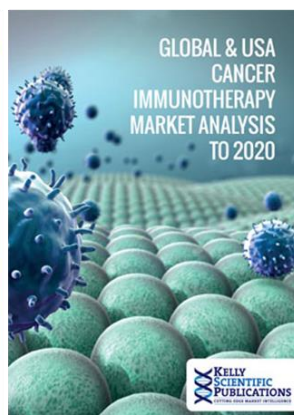
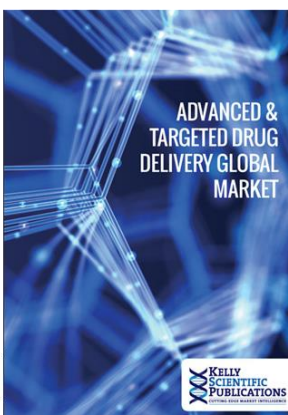
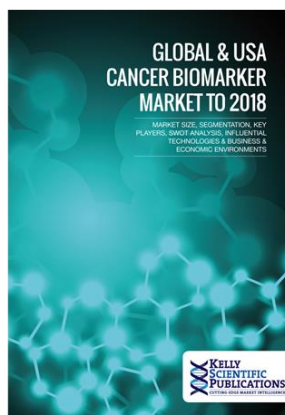
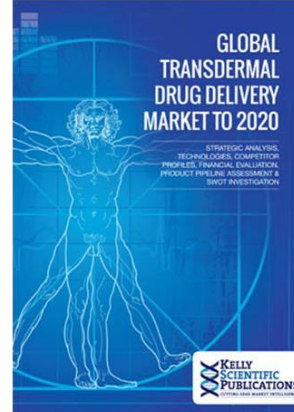
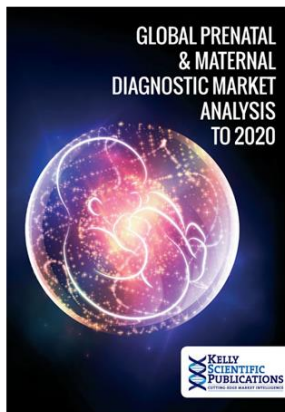
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**Personalized Medicine, Targeted Therapeutics & Companion Diagnostics Market
To 2019
Published February 2016**

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1.0 Executive Summary

“**Personalized Medicine, Targeted Therapeutics & Companion Diagnostic Market: Strategic Analysis of Industry Trends, Technologies, Participants, and Environment**” by Kelly Scientific Publications is a comprehensive report on the personalized medicine industry and its impact on the health system. This report tackles the growing market interest in pharmacogenomics, targeted therapeutics, companion diagnostics, liquid biopsies and the associated market environment.

Individualized, targeted or personalized medicine aims to increase the efficacy of therapeutics via genetic testing and companion diagnostics. Personalized therapeutics and associated companion diagnostics will be more specific and effective thereby giving pharma/biotech companies a significant advantage to recuperate R&D costs. Personalized medicine will reduce the frequency of adverse drug reactions and therefore have a dramatic impact on health economics. Developmental and diagnostic companies will benefit from lower discovery and commercialization costs and more specific market subtypes.

This report describes the current technologies that are propelling the personalized medicine and companion diagnostic market. It examines the current genetic diagnostic tests and companion diagnostic assays that are in use by the medical and pharmaceutical industry today. Current developments in personalized medicine and the pharmacogenomics revolution are discussed. The emerging trends that appear in key markets such as the US, UK, Germany and France are elucidated and analysed. This study reveals market figures of the overall personalized medicine market and also sub-market figures.

The study also provides a comprehensive financial and product review of key players in the personalized medicine industry. Strategic drivers and restraints of this market are revealed and market opportunities and challenges are identified.

In summary, the personalized medicine and associated companion diagnostic market have huge opportunities for growth. This industry will revolutionize the healthcare system and will improve therapeutic effectiveness and reduce the severity of adverse effects. It has enormous potential for investment and the emergence of genetic-based in vitro diagnostics.

1.1 Objectives of Report

This is a comprehensive account of the market size, segmentation, key players, SWOT analysis, influential technologies, and business and economic environments. The report is supported by over **360 tables & figures over 393 pages**. The personalized medicine (global and USA) market is presented as follows:

- By **Company** (e.g., QIAGEN, AFFYMETRIX, ATOSSA GENETICS, NODALITY, deCode /Amgen, CELERA, MYRIAD)
- By **Segment** (Targeted therapeutics, Companion Diagnostics)
- By **Sub-market** (Companion diagnostic, targeted cancer therapeutic, medical technology, pharmacogenomics, consumer genomics, molecular diagnostics, liquid biopsy)
- By **Therapy** (Cancer, Cardiovascular, Infectious Disease)

A wealth of **financial data & business strategy information** is provided including:

- Company Financials, Sales & Revenue Figures
- Business Model Strategies for Diagnostic, Pharmaceutical and Biotechnology Companies
- Business Model Strategies for Providers. Provider Systems and Academic Medical Centres
- Business Model Strategies for Payers & Governments
- Private and Public Funding and Personalized Medicine Reimbursement

- Revisions to Current Payment Systems and Intellectual Property
- How to Gain Market Penetration in the EU
- Cost-effectiveness and Business Value of Personalized Medicine
- Consumer genomics and POC market
- Therapeutics and Companion Diagnostics (e.g., BRAC Analysis, Oncotype Dx , KRAS Mutations)
- Comprehensive Account of Company Product Portfolios & Kits

SWOT, Economic & Regulatory Environment specifics include:

- Key Strengths, Weaknesses and Threats Influencing Leading Player Position within the Market
- Technologies Driving the Market (e.g., New-Generation Sequencing Technologies, Ultra-High Throughput Sequencing)
- Top Fastest Growing Market Segments and Emerging Opportunities
- Top Pharmaceutical Companies within the IPM by Market Share and Revenue
- Comprehensive Product Portfolios, R&D Activity and Pipeline Therapeutics
- M&A Activity and Future Strategies of Top Personalized Medicine Pharmacos
- Personalized Medicine Regulation (UK, Germany, France, Spain, Italy)
- CE-Marked Personalized Medicine/Diagnostic Tests
- FDA Advances in Personalized Medicine Regulation

This report highlights a number of significant players and influential company's and gives details of their operations, products, financials and business strategy.

- | | |
|---|----------------------------------|
| • 23andMe | • HalioDx |
| • Abbott Laboratories | • Ikonisys |
| • Abbott Molecular Inc. | • Illumina |
| • Admera Health (GENEWIZ) | • InterGenetics |
| • Affymetrix | • Johnson & Johnson |
| • Agendia | • LabCorp |
| • Alere | • Life Technologies |
| • Amgen | • Merck |
| • Astex Pharmaceuticals | • MDxHealth |
| • AstraZeneca | • MolecularMD Corporation |
| • Atossa Genetics | • Monogram Biosciences |
| • Becton Dickenson | • Myriad |
| • bioMerieux | • Nodality |
| • BristolMyersSquibb | • Novartis MDx |
| • Cancer Genetics | • Orion Genomics |
| • Celera (Quest Diagnostics) | • Oxford BioTherapeutics |
| • Celldex Therapeutics | • NanoString Technologies |
| • Claritas Genomics | • Pfizer |
| • CuraGen | • Qiagen |
| • Danaher (Leica Biosystems) | • Roche Molecular Diagnostics |
| • deCode Genetics (Amgen) | • Sanofi |
| • Foundation Medicine | • SensiGen |
| • EDP Biotech | • Siemens Healthcare Diagnostics |
| • Eli Lilly | • Takeda |
| • ELDA BioTech | • Thermo Fisher Scientific |
| • Eisai | • Transgenomic |
| • Genelex | • Ventana (Roche) |
| • GlaxoSmithKline | • Vermillion (CIPHERGEN) |
| • Human Longevity Inc (Cypher Genomics) | • Vertex Pharmaceuticals |

Updates on the personalized medicine, targeted therapeutic and companion diagnostic space have been included in this latest edition to include cutting edge material from international conferences, workshops and symposia.

1.2 Scope of Study

The combined personalized medicine market is sub divided into the following areas:

- Core Personalized Medicine – targeted therapeutics, companion diagnostics, rare disease diagnostic services
- Personalized Medical Care – disease management, electronic medical records and remote patient monitoring/telemedicine

This report focuses mainly on the core personalized medicine market which is companion diagnostics and targeted therapeutics, however it also reveals the current combined market value as well as those from the liquid biopsy and molecular diagnostics markets. The study provides a comprehensive description of current companies with an interest in personalized medicine and their financial and product portfolios. This paper also identifies key technologies that are driving the personalized market and current restraints and challenges that may weaken it. The report focuses on the US and European personalized medicine markets as they are at the forefront of this emerging industry.

1.3 Data Sources and Methodology

The project leader and author of this research obtained a Ph.D. in Medicine from the Royal College of Surgeons in Ireland, following completion of a M.Sc. in Biotechnology (NUIG) and an honours degree in Biochemistry from Trinity College Dublin. She has extensive experience in genetics and pharmacogenomic research and development and conducted post-doctoral studies and lecturing in Trinity College Dublin. With many years of medical writing and publishing the author also has extensive experience and knowledge of molecular biology, immunology, bioinformatics and diagnostic testing. As a pharma/biotech industry analyst she has significant expertise in laboratory diagnostic testing and instrument and reagent development technology.

Sources of information for this report were collected and compiled from company specific corporate websites, annual reports, press-releases, international scientific and medical journals and news and research reports. Graphical and numerical data have been referenced and sourced accordingly. Specific websites were consulted and referenced throughout the completion of this report including that of the personalized medicine coalition (www.personalizedmedicinecoalition.org), the Food and Drug Association (www.fda.gov), the National Cancer Institute and other government agencies worldwide. Kelly Scientific Publications has used the most recent statistical and numerical data available. The most reliable of data sources were used in the production of this report, however we cannot guarantee complete accuracy or completeness from secondary information sources.

1.4 Key Findings and Observations

Over the last 20 years genetic advances have facilitated the emergence of personalized medicine as an emerging player in the healthcare system. Sequencing of the human genome has sparked the field of pharmacogenetics – the analysis of inter-individual genetic mutations and the impact of such on drug responsiveness. Personalized medicine also takes pharmacogenomics studies into account where the combination of genetic and protein interactions yield potential drug targets. The overall objective of personalized medicine is to provide individualized care that is more specific and therefore more effective.

Technological advances have reduced the price of sequencing the human genome dramatically in the last decade. In 2000 it cost in the region of \$10,000 per million base pairs using Sanger sequencing. This was reduced to \$1,000 per million base pairs in 2005 by 454 pyrosequencing. Sequencing by

synthesis and sequencing by ligation reduced this cost further. Today it only costs \$1 per million base pairs using third generation sequencing.

The cost of adverse reactions to the US economy annually is reported at \$136 billion, with over 450,000 cases stated. In the UK the cost of adverse reactions equals £466 million annually. Over the coming years, pharmacogenomics studies aim to reduce the number of ADRs and so improve the safety of medication.

Over the next five years Kelly Scientific Publications predicts that genetic testing will be a significant first-line assay for many common genetic disorders including lung, colorectal and breast cancer, cardiovascular disease and depression. A number of top therapeutics today are influenced metabolically by genetic mutations, such as:

- Atorvastatin
- Clopidogrel
- Esomeprazole
- Fluticasone/Salmeterol
- Etanercept
- Olanzapine
- Risperidone
- Darbopoetin
- Venlafaxin
- Amlodipine

The FDA approved a wide range of drugs that are subject to genotype-specific dosing including warfarin, diazepam and codeine. To date there are over 85 companion diagnostic FDA approved tests on the market and 500 identified biomarkers, including the following:

1.4.1 CYP2C9 and VKORC1 mutations and Warfarin Response

In late 2007 the FDA has approved both CYP2C9 and VKORC1 genetic tests with regards to warfarin testing and is currently in the range of \$500 per test. Currently Genelex, Nanosphere, Osmetech and Paragon Dx sell warfarin genetic tests.

1.4.2 KRAS Mutations

Cetuximab (Erbix) and panitumumab (Vectibix) are two chemotherapies that are not effective in *KRAS*-positive tumours. The National Comprehensive Cancer Network (NCCN) issued guidelines that recommend that patients with metastatic colon cancer have *KRAS* mutation analysis. Most insurers cover *KRAS* testing.

1.4.3 Herceptin® and Breast Cancer

Herceptin® (trastuzumab, Genentech) was FDA approved for use in breast cancer patients in 1998 at a cost of \$50,000 to \$100,000 annually. However, subsequent analysis indicated that Herceptin was only effective in 25-30% of women whose tumour cells over synthesized the protein human epidermal growth factor-2 HER2/Neu. By 2006 all invasive breast cancer patients were recommended to take the HER2 genetic test to identify if they would respond to Herceptin treatment.

1.4.4 BRACAnalysis®

BRACanalysis® by Myriad Genetics is a test to determine whether women have a higher risk of hereditary breast and ovarian cancer (HBOC) syndrome. HBOC syndrome is known to cause 10% of all breast and ovarian cancers and can be detected by mutations in the *BRCA1* or *BRCA2* genes.

1.4.5 Oncotype Dx Test

The Oncotype DX test from Genome Health can detect a number of different genetic mutations to detect early-stage (stage I or II), node-negative, estrogen receptor-positive (ER+) invasive breast

cancer. Women who have undergone this test and resulted positive have saved in the region of \$2,000 worth of chemotherapy. Given that around 100,000 women are diagnosed annually, this would save \$200 million per year.

1.4.7 New Business Model Required for Personalized Medicine

Integration of personalized medicine into the current health industry will not come without its challenges. Aside from the requirement of novel technologies and scientific/therapeutic discoveries this new consumer focussed market will need collaboration between existing players in the market to fully succeed. Currently there is a high number of pharma and biotech companies with interests in personalized medicine, however it is predicted that non-health care companies will also enter the fold. The entry of non-healthcare companies such as Proctor and Gamble will be extremely beneficial to the industry as they supply consumer targeting expertise and so raise market expectations within the wellness submarket.

1.4.8 Cost-effectiveness and Business Value of Personalized Medicine

The potential of personalized medicine to revolutionize the healthcare system is evident, however will the cost of doing so allow the market to grow in the future? The major personalized medicine companies generated billions in revenue in 2015, however analysis of payment systems and the cost-effectiveness of personalized medicine must be performed in order to achieve an overall perspective on this rapidly growing market.

1.4.9 Personalized Medicine Market

KellySciPub forecasts that the total personalised therapeutic market, for all indications, will be worth \$x billion by 2020, with a CAGR of 6.47%. Currently it is estimated that the companion diagnostic segment is worth \$x billion globally, mainly coming from oncology, cardiovascular and infectious disease (HIV/HCV) tests. This is set to rise vertically over the next five years and by 2020 will be worth over \$x billion, with a CAGR of 23.71%. **Combined, KellySciPub forecasts that the companion diagnostic and targeted therapeutic market of personalized medicine was worth \$98 billion in 2014, and will hit over \$149 billion by 2020 with a CAGR of 8.74%.**

1.4.10 Personalized Medicine Oncology Therapeutics & Diagnostics Market

Overall, the personalized medicine oncology therapeutics market was worth in the region of \$x billion in 2014, and was mainly dominated by sales of Herceptin, Gleevec, Revlimid, Avastin and Alimta. Due to patent expirations and pipeline therapeutics emerging in the market space, this environment will change over the next five years. KellySciPub forecasts that this market will be worth an estimated \$x billion by 2019, with a CAGR of 5.2%.

1.4.11 Personalized Medicine Cardiovascular Therapeutics Market

The current personalized medicine branded cardiovascular therapeutic market is worth \$x billion, however within the next five years it is expected to decline mainly due to generic competition of Plavix. By 2019, this market will decline at a CAGR of 12.2% to \$x billion.

1.4.12 Pharmacogenomics/Pharmacogenetics Market Analysis

The Pharmacogenetics market is encapsulated within the overall genomics testing market, which also includes oncology diagnostic testing, inherited disease testing and HLA analysis. The global genomic testing market is currently worth just over \$x billion, and this will see vertical growth to almost \$x billion by 2019, with a CAGR of 10.35%.

1.4.13 Liquid Biopsy Market Analysis

The two segments of the liquid biopsy market are tumor cell enrichment products and tumor cell detection technologies. Tumor cell enrichment involves filtration, immunological and immunogenetic methods, and centrifugation. In 2014, tumor cell detection had the largest share of liquid biopsy market. Region-wise, North America had the largest share in the market with Europe and Asia/Pacific in the second and third position respectively. In Asia/Pacific, India and China are the the largest markets. With a huge patient base for cancer, in almost all the geographic regions, the liquid biopsy market was worth about \$x million in 2014 and this is likely grow swiftly with a CAGR of 20.6% and reach a market worth of about \$x billion in 2021.

Personalized medicine is an emerging industry, and is predicted not to fully integrate into the healthcare system for the next 20 years. Until then, there are many challenges and hurdles facing the market including regulatory and reimbursement issues. The gap between genotypic association with disease and clinical relevance is also a concern; however with increasing advances in technology and computer software programs, personalized medicine will grow strongly.

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