

White Paper

PREDICTIVE ANALYTICS IN ONCOLOGY

*How Artificial Intelligence Drives Greater Precision
for Pharma Brands*

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INTRODUCTION

In the world of innovative oncology drug sales and marketing, the ability to foresee when an oncology patient is ready to start initial treatment or switch to next line therapy represent fleeting moments of opportunity. These are the brief windows of time to link the right patients to the right treatments for the best possible outcomes.

The challenge that sales and marketing teams face is identifying those moments before treatment decisions are made.

Marketing any pharmaceutical product requires carefully crafted campaigns that educate healthcare professionals about the best treatment options for a specific patient at the right point in time. In oncology, where patient populations are relatively small, and treatments are indicated for multiple tumor types, that timing has been difficult to anticipate – until now.

Advances in big data analytics and artificial intelligence (AI) make it possible to predict when patients may need to start initial treatment, or may be moving to the next line of treatment, as well as which physicians are

treating them. These predictive analytics can eliminate the trial-and-error approach to marketing oncology products and empower sales and marketing teams to deliver more precise physician engagement. The result? Personalized treatment for the right patient at the right time, providing better patient outcomes.

But while there is power in predictive analytics, not all models are created equal. Pharmaceutical companies need partners with access to diverse global healthcare data and the expertise to develop advanced machine learning models that can leverage human data science to accurately identify these patients. The right combination of science and data has been proven to deliver impressive results.

IQVIA's predictive analytics can eliminate the trial-and-error approach to marketing oncology products and empower sales and marketing teams to deliver more precise physician engagement.

THE ONCOLOGY MARKETPLACE

Oncology research has hit incredible highs in recent years. Advances in immunotherapies and targeted therapies have transformed cancer treatment, promising to provide better quality of life, greater longevity, and in some cases, full remission.

These advances are drawing significant attention and investments as the number of approved cancer therapies continues to rise. From 2014-2018, 57 oncology drugs were launched, gaining 89 indications across 23 different cancer types.ⁱ In 2018, a record 15 new oncology therapeutics were launched – more than half of them are delivered as an oral formulation, have an orphan indication, or include a predictive biomarker on their label.ⁱⁱ The rapid pace of investment is likely to continue. There are currently 711 companies active in late-stage oncology R&D, working on a total of 849 products, including 29 academic institutions, 626 emerging biopharma (EBP) companies, and 28 large companies with global revenues over \$5 billion.ⁱⁱⁱ

These innovative therapies are changing the oncology landscape, but the drugs used most often and that work the best are very expensive. The top 38 cancer drugs account for 80 percent of total spending^{iv} leading to competition amongst the key drugs.



With competition increasing, pharma companies can leverage predictive analytics to drive more precise and custom sales and marketing efforts. When used effectively, medical science liaisons (MSLs), nurse educators, and sales teams can align their efforts to the specific needs of patients, raising awareness for the best treatment options. In turn, lifesaving treatments can be delivered to patients at their point of need while maximizing the sales performance of these innovative drugs.

ARTIFICIAL INTELLIGENCE: PRECISION MARKETING FOR PRECISION MEDICINE

Because oncology drugs target smaller, highly-specific patient populations, sales teams are much smaller and more spread out. Pharma companies may have as few as 10 reps for an entire country – a striking difference from the thousands of reps who promote drugs that target high prevalence conditions.

These reps may be responsible for an entire state or region, and target oncologists who care for a variety of patients with a range of cancers and treatment needs. Additionally, most innovative oncology drugs are often approved as later line therapies to treat specific subpopulations with a cancer type. For these therapies, sales efforts need to be precisely timed within the narrow window of need when a patient isn't responding to a first line treatment but hasn't yet moved on.

To get the best treatment to those patients, sales reps need predictive analytics that tell them which patients may need their treatment and when. They can use these insights to educate physicians about relevant treatment options, time their sales efforts, and customize messages to individual patient needs.




i Global Oncology Trends 2019. May, 2019. IQVIA Institute.

ii Global Oncology Trends 2019. May, 2019. IQVIA Institute.

iii Global Oncology Trends 2019. May, 2019. IQVIA Institute.

iv Global Oncology Trends 2019. May, 2019. IQVIA Institute.

IQVIA applies predictive analytics in proactive targeting to develop a more focused, tailored, and timely target list

TARGETING METHOD	TARGET AUDIENCE/ACTIONS	OUTCOME(S)
REACTIVE TARGETING  Broad Reactive HCP Targeting	<ul style="list-style-type: none"> • Patients already on therapy • Report historical treatment events 	Reactive alerts and targeting: A broad list of HCPs
PROACTIVE TARGETING: RULES-BASED  Broad Proactive HCP Targeting	<ul style="list-style-type: none"> • Identify patients with a couple of known clinical indicators for an upcoming therapy transition • Report a few trigger events based on business rules (i.e. treatment guidance) 	Proactive alerts and targeting: A broad list of HCPs
PROACTIVE TARGETING: PREDICTIVE MODELING  Proactively Focused HCP Targeting	<ul style="list-style-type: none"> • Analyze patient's treatment attributes and timing • Run predictive models among those potential predictors and their interactions • Simplify and validate models for high model performance 	Proactive alerts and targeting tailored to HCPs: Provide time-sensitive information on treatment indication Improve sales call targets A more focused target list

HOW IT WORKS

Cancer patients have critical milestones throughout their disease journey that trigger treatment decisions. AI algorithms can be trained to analyze anonymized patient longitudinal healthcare data to identify key triggers in that journey, such as doctor's appointments, prescriptions, symptom reports, hospital visits, lab results, and patient profiles. These AI algorithms can be built to predict disease detection, treatment initiation, line of therapy transitions, and disease progression with precision.

AI algorithms deliver a number of benefits:

- AI algorithms can detect undiagnosed patients and identify patients with the disease who are likely to benefit from a specific therapy. The algorithms analyze patterns in pharmacy claims, electronic medical/health records, lab/biomarker data, medical claims, specialist visits, and other healthcare data. Once identified, the models can link those patients to treating physicians.

- AI algorithms can help generate lists of high value healthcare professionals using real-time predictions of eligible patients in the area and the number of existing patients under their care.
- AI algorithms can build influence maps showing individual providers' profiles, academic affiliations, industry connections, board certifications, areas of interest, and adoption behavior to inform more strategic marketing campaigns.
- Pharmaceutical companies can use all of these data to inform sales force size, structure, call frequency, and prioritization based on the predicted opportunities for maximum returns on sales and marketing efforts.
- Sales and marketing teams can strategically plan from dashboards enhanced with AI algorithm outputs, determining which providers to engage with and when for more successful campaigns.

This proactive approach to oncology sales and marketing doesn't just benefit pharma companies. The positive impact cascades to stakeholders across the oncology community.

- It ensures patients have access to the best treatment options, which reduces the risk of delayed or less effective treatment.
- It saves physicians time and increases therapeutic knowledge by providing information when it is most relevant.
- It helps to demonstrate the value of medicine for payers who need to justify the high price tags. When physicians are able to accelerate treatment decisions with the right medicine at the right time, they can lower the risk of ancillary care costs and potentially improve patient outcomes.

REAL WORLD RESULTS: PREDICTING FIRST AND SECOND LINE TREATMENT OPPORTUNITIES

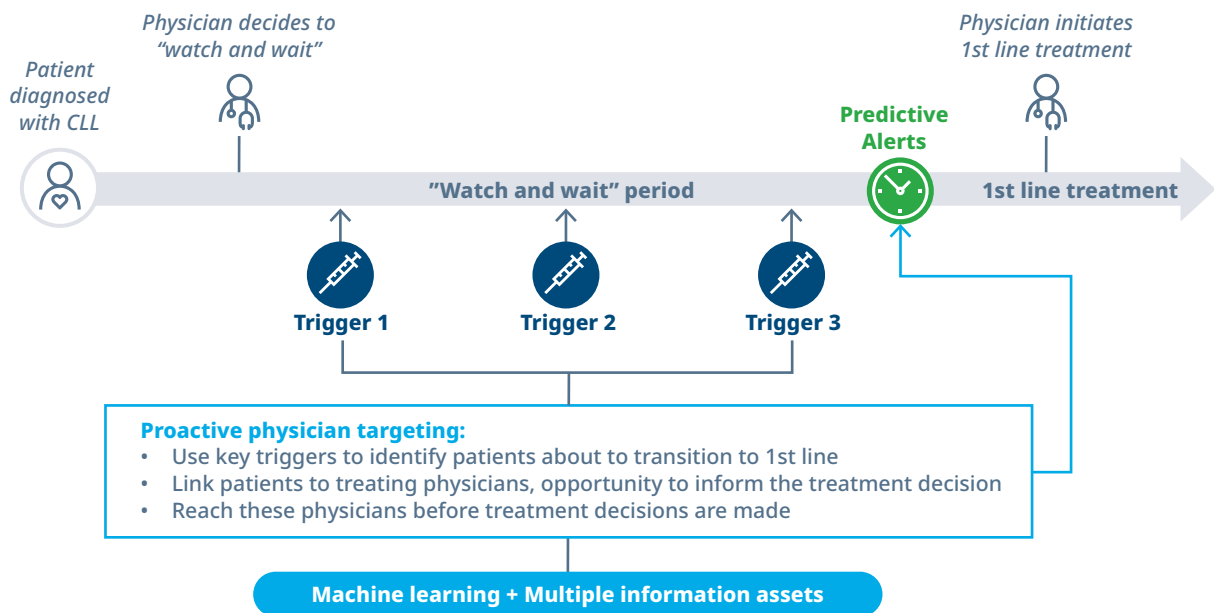
IQVIA is using these advanced algorithms and modeling approaches to optimize sales strategies in real time, and customers are seeing measurable business results.

MONITORING DECISION TRIGGERS

IQVIA is leveraging our robust oncology patient data assets, using AI algorithms, and oncology clinical domain knowledge to identify when a treatment decision is going to be made for a patient.

For example, physicians treating patients with slow growing tumor types often take a “watch and wait” approach, delaying first line treatment until the disease starts actively progressing. Pharmaceutical companies promoting treatments for these cancers are challenged to align their sales strategies with these decision triggers.

Case Study: Identify 1st Line Chronic Lymphocytic Leukemia patients before 1st Line treatment decision



IQVIA's predictive analytics models addresses this need by identifying patients nearing first line therapy based on analysis of historic disease data, medications, symptoms, lab tests, and co-morbidities. In one project, the AI algorithm is six times more accurate than rules-based models for prediction, and nearly twice as accurate as linear regression models for the same condition.

Sales teams can use these insights to prioritize physicians who have a high number of potential patients, customize acquisition strategies for new patients, and personalize physician engagement before treatment decisions are made. Predictive alert reports then help them adapt their sales strategy and call lists in response to evolving needs.

SECOND LINE TREATMENT TRIGGERS AND VALIDATED TRENDS

AI algorithms can also be used to predict line progression, pinpointing the transition moment to a next line of therapy. These treatment decisions are often made during a short window of time and can vary based on physician attitude, their knowledge of new treatment options, and results of lab tests and related symptom reports. By combining AI with our oncology clinical domain knowledge, IQVIA can analyze real world data and create algorithms that predict which patients are about to progress to next line therapy with a high degree of accuracy.

For a treatment for lymphoma patients, IQVIA was able to identify and rank treatment progression using a probability index and treatment triggers, which made it possible to link them to treating physicians.

Case Study: Using AIML-powered predictive alerts for line progression among treated Lymphoma patients

Situation

- Client wanted to strategically leverage “Proactive Targeting” to reveal potential patient targets during their treatment journey and therapy progression
- IQVIA was asked to help identify HCPs about to treat B-cell lymphoma patients on line progression who could be candidates for this product

Solution

- Leveraging machine learning models and clinical expertise, IQVIA identified patients already receiving treatment who were about to progress to next line therapy
- IQVIA linked high potential patients to their treating physicians and designed a user-friendly predictive alert report delivered bi-weekly

Result

- Superior predictive results compared to a rules-based approach, combining machine learning models with oncology clinical domain knowledge
- The client actively uses the report for proactive physician education and communications

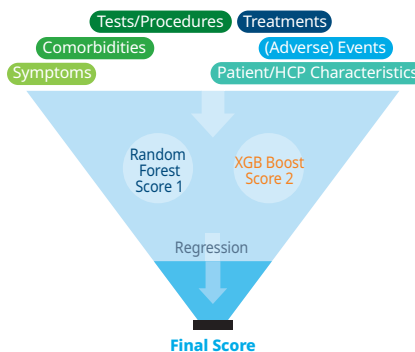
Identify Patients & Key Triggers

Patient	HCP	Outcome Variables	Significant Triggers		
		Score	Trigger 1	Trigger 2	Trigger 3
0001	****	95%	F1	F3	F7

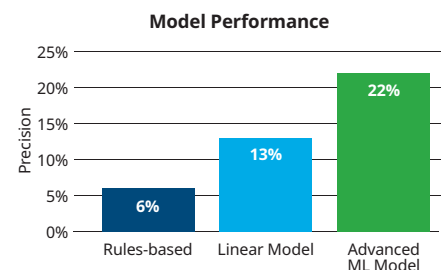
- Rank/select patients based on predicted scores
- Significant triggers are specific to individual patient
- Each patient's treating physicians are identified

Machine Learning Model

The champion model: a stacking model combining RF and XGB



Excellent Performance



IQVIA has created a model to identify non-small cell lung cancer patients, with tumors between three and four centimeters in size – who were about to transition to a second line therapy. Using machine learning models that analyze real world data, IQVIA created an algorithm to identify specific triggers that indicate disease progression to second line treatment.

Across the industry, journals document the growing trend to adopt AI for oncology. For example, in a paper published in the Proceedings of Machine Learning Research, the authors developed the Wide and Deep Neural Network incorporating prior medical knowledge to predict the treatment initiation for Waldenstrom Macroglobulinemia patients. When they compared the accuracy of predictions from Deep Neural Network with various machine learning models, the Deep Neural Network achieved significantly better results in predicting the start of treatment.^v

Similarly, in the paper accepted by the 2019 International Conference on Machine Learning, the authors conducted experiments using real world data to predict the initiation of first-line treatment for Chronic Lymphocytic Leukemia patients and several other diseases. The results show their method can improve prediction over alternative machine learning models.^{vi}

These examples further highlight how AI use in oncology is evolving and can potentially change the way research is conducted.

CONCLUSION: CONSIDERATIONS FOR SUCCESSFULLY LEVERAGING AI IN ONCOLOGY

People have been talking about AI for years and many companies have recently launched models that promise exciting results. However, success has been inconsistent.

When deciding on AI-driven solutions for oncology, it is important to assess the precision of the algorithms, the relevant data sets that feed each algorithm, and the human experience in custom-designing AI algorithms for complex healthcare challenges.

IQVIA builds custom algorithms and trains them using a broad collection of oncology data sets, delivering a higher level of accuracy than traditional models. Our AI platform can integrate and analyze various datasets and compare results across a diversity of linked databases to validate outcomes and eliminate bias.

Once the algorithms are trained, they are tested against another validation dataset to boost signals and optimize parameters in the final model before it is deployed. This combination of data, algorithms, and tiered vetting system ensures our algorithms are as reliable and accurate as possible.

This is the key to predictive analytics: it only works if the quality and volume of data is appropriate to generate meaningful insights. Prior to developing algorithms, data scientists spend considerable time on data cleaning, quality control, linking data assets, and formatting to ensure the input is reliable. Having the expertise and advanced technology to conduct such data curation and management is a prerequisite to creating effective AI solutions.

v Predicting Treatment Initiation for Waldenstrom Macroglobulinemia Patients via Deep Neural Network with Prior Medical Knowledge, Machine Learning for Healthcare, Proceedings of Machine Learning Research 00:1–18, 2019.

vi Predicting Treatment Initiation from Clinical Time Series Data via Graph-Augmented Time-Sensitive Model, Proceedings of the 36th International Conference on Machine Learning, Long Beach, June 2019

Predictive analytics can have significant impact in many areas of drug development and commercialization. It is especially relevant for oncology and other rare disease categories. When populations are small and dispersed with limited treatment options, finding patients at the right time through the right physicians is vital to delivering the best treatment options.

When pharmaceutical companies can access the right data, technology, analytics and industry expertise, it becomes possible to find patients in need and recommend the best course of treatment at the right time. This will drive tangible benefits for patients, empower physicians, and drive positive sales and healthcare outcomes for stakeholders across the oncology community.

For more information about IQVIA's AI oncology analytics visit iqvia.com/contactus

Why IQVIA? *Thought leadership and key success factors*



LINKABILITY - With other patient datasets to overcome EMR limitations



SCALABILITY - Experience integrating large EMR and other data vendors



WORKING EXPERIENCE - Strong partnership with Commercial and HEOR organizations



COLLABORATION- We have experience integrating our solution with other vendors



SCIENTIFIC EXPERTISE - Guidance, a Partnership approach, data generalizability, Epidemiology and HEOR (we know how to answer complex research questions)



TECHNOLOGY- (Optional Platform), Analytics, e360, CMOP Standards, Integration of all data across various sources

ABOUT THE AUTHORS



LI ZHOU, MS

Senior Principal,
Advanced Analytics, IQVIA

Li has 20 years of experience in the pharmaceutical industry specialized in market science and marketing research. As a Sr. Principal of Advanced Analytic group, she leads a highly experienced group focused on Predictive Analytics using AIML, projection, statistical modeling, marketing research and consulting. This group supports high-end analytics projects focused on physician targeting as well as patient-level studies and data assets projections integrating pharmacy, medical, hospital, lab and payer level data.

Li has a MS degree in Industrial Engineering with a specialization in Operations Research and MIS from the University of Alabama.



MELISSA MARTH, MS

Vice President and GM,
Real World Oncology, IQVIA

Melissa Pirolli is Vice President of Oncology, Real World Insights (RWI) at IQVIA. Melissa has over 15 years of experience analyzing real world data including both primary and secondary healthcare data. Over the past twelve years, Melissa has specialized in the hematology/oncology and non-malignant hematology therapeutic space.

Melissa leverages her advanced statistical skills and clinical knowledge to support forecasting, market sizing, health outcomes research, safety, payer reimbursement, and launch excellence. Utilizing anonymized, longitudinal patient level claims and EHR/EMR data, Melissa has published several papers in journals (Cancer Medicine, Supportive Care in Cancer, Breast Cancer Research and Treatment) and presented posters at conferences (ESMO, ASCO, ASH, MASCC, SABCS).

Prior to joining IQVIA, Melissa conducted primary market research projects at TVG. Melissa performed segmentation analysis, fielded/analyzed quantitative online studies, and developed/conducted in-depth interviews with physicians, patients, and payers. Melissa holds a BA in mathematics and MS in computational mathematics from Duquesne University.



LYNN LU, MS

Senior Principal,
Advanced Analytics, IQVIA

Lynn Lu is a Senior Principal within Advanced Analytics group at IQVIA. With a focus on oncology analytics, she provides guidance regarding commercial strategy, patient journey, treatment algorithms, predictive analytics and innovative sales and marketing tools with clinical insights.

Lynn has over 25 years of experience in sales and marketing analytics with deep expertise in longitudinal patient-level oncology data and its applications in market sizing and treatment patterns. She leads customized research projects that drive direct insight into patient and provider behavior and specific brand growth opportunities. Lynn plays a key role in multiple offering innovations including Advanced Targeting, Physician Segmentation and Potential Opportunity, Proactive Trigger Alerts and Provider Influence Mapping.

Before joining IQVIA, Lynn held a Senior Director position at Pharmacyclics (An AbbVie Company) managing commercial information and analytics. She also held a strategic leadership role at Amgen managing marketing analytics for \$8 Billion Oncology product portfolio and helped build the Oncology Patient Level Data Warehouse by working with multiple organizations and vendors.

Lynn earned an MS in Economics and a BS in Finance.



EMILY ZHAO, PhD, MS

Vice President,
Advanced Analytics, IQVIA

Emily Zhao has extensive experience in data analytics leveraging statistical models, artificial intelligence and machine learning. Drawing on her deep knowledge and expertise in healthcare data analytics and its business applications, she leads a team of statistical modelers, data scientists and consultants to construct healthcare commercial effectiveness and real world insights solutions to drive brand strategy and optimize outcome. She provides leadership in both strategic directions and technical innovations.

Prior to joining IQVIA in 2011, Dr. Zhao was a marketing analytics director at Farmers Insurance. There she led predictive analytics for customer acquisition and retention, and pioneered media purchase models to optimize media buys for TV and digital channels. Previously, she had served as data analytics director at UnitedHealth Group, and had worked in advanced analytics functions for marketing and sales at Schering-Plough (now Merck). She had also been a computational biology and bioinformatics consultant for GSK, mining R&D high-throughput data from pre-clinical and clinical settings to understand drug treatment effects. Her rich and diverse set of experience and expertise have brought deep appreciation of the analytics methodology and technology advancements across industries, and afforded her wholistic understanding of the opportunities and challenges facing the healthcare industry.

Dr. Zhao holds a PhD in Immunology from the University of Pennsylvania School of Medicine and an MS in Engineering in Computer and Information Science from the University of Pennsylvania School of Engineering. She also holds a postgraduate Marketing Certificate from the Wharton School. She presents at industry conferences regularly and serves as a panelist on thought leadership discussions.

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