Data driven decisions in cancer care: How using analytics on EMRs and biomarkers will improve patient outcomes

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EMR- and biomarker-based diagnostics are no longer novel in oncology, but ubiquitous. As this data environment is advancing, however, several factors hinder greater use of automation and analytics-driven decisions. This paper examines these limitations and suggests solutions. Addressing these challenges will unlock a new era in cancer patient outcomes, focusing the impact of the rapidly expanding arsenal of therapies available to an oncologist on mutation-based combinations derived from expanded diagnostics.


The development of oncology treatments has grown rapidly over the last two decades. The number of active compounds in clinical development quadrupled between 1998 and 2018, and nearly doubled in the last decade alone, with more than 1,600 compounds reported today in phase I-III clinical trends data.

At the same time, an unprecedented amount of data is being generated, stored, analysed, and consumed in healthcare. This data is coming from a variety of sources, including patients, providers, pharma companies, and payers. More than 13 million electronic medical records (EMRs) exist for cancer patients in the United States alone.

In addition, the global market for next generation sequencing is expected to grow by 21% annually from 2017 to 2022. In particular, the cancer biomarker market is projected to reach about USD20 billion in 2022 from about USD11 billion in 2017, driven by lower sequencing costs, increasing diagnostic applications of biomarkers in oncology, and a paradigm shift to one-test-one-patient.

In this environment, data use in oncology is exploding across all dimensions. Half of all drug submissions for Health Technology Assessments (HTAs) now use Real World Evidence (RWE), payer spend on data and analytics has grown 20% annually in recent years, and several new oncology data aggregators have emerged with backing from major venture capitalists and partnered with large pharma companies. In one example, large healthcare technology companies have developed cloud-based platforms in oncology informatics to assist with treatment decisions and promote guideline adherence. Also, select in-vivo diagnostics companies have established partnerships with top biopharmaceutical companies to develop decision-support systems, including a dashboard for oncology care teams with combined in-vivo and in-vitro diagnostics to align on treatment decisions.

In addition, rising technologies like liquid biopsy allow minimally invasive, repeated testing along the treatment cycle that complement tissue biopsy. Ultimately, these technologies may allow for screening and early detection for high-risk patients with established biomarkers. Recent approvals of biomarker-based, indication-agnostic treatment and liquid biopsy companion diagnostics in oncology – for example, the US Food and Drug Administration (FDA) has approved the Epidermal Growth Factor Receptor (EGFR) detection
test – are milestones of precision medicine. Further, detection of measurable residual disease (MRD) enables greater sensitivity to assess response to treatment, detects relapse, and can accelerate decisions.

Finally, there is a large ongoing effort to aggregate data and generate insights by creating bigger and more comprehensive and longitudinal data sets of oncology patients. Several oncology analytics partnerships are already demonstrating how individual efforts around genomic data or clinical data can combine to generate valuable insights. Also, large provider systems and academic institutions have been developing aggregated data positions with patient consent.

Amid all of this activity in oncology – from clinical development to data aggregation – a dizzying array of treatment options and pathways is emerging. Compounded by the rising costs of these technologies, a compelling opportunity arises for systems and machines that are robust and sophisticated and can help medical professionals untangle the growing complexities of oncology care.

Emerging challenges in cancer care

The increasing complexity of immuno-oncology (IO), greater stratification of cancers, and a proliferation of biomarkers will make it impossible for physicians to keep pace, making optimal clinical decisions more and more difficult. IO is an experiment of unprecedented diversity, scale, and complexity. For example, the number of companies sponsoring trials for PD-(L)1 or CTLA-4 grew 70% a year between 2011 and 2018 and the monthly diversity of major tumour indications remains high, with about 43% of major tumour types having new cohorts launched each month4.

Two factors are pushing the increased complexity of patient-specific biomarker information: the switch to multigene panels and the gradual lessening of reimbursement challenges. While companion diagnostics that guide therapeutic decisions directly remain the most frequent use of biomarker generation, new emphasis is being placed on multigene panels rather than single biomarker characterisations, with 83% of oncologists using multigene panels. Payer coverage of companion diagnostics is expected to expand and drive biomarker growth, as well, yielding greater opportunities for quantifying patient response in a multiple-mutation context. Indeed, already companion diagnostics are relatively common, despite a difficult reimbursement environment: only 38% of managed care organisations (MCOs) cover FDA-approved companion diagnostics.

Taken together, these factors will provoke a data avalanche for physicians. But even as the complexity of biomarkers becomes overwhelming for physicians, oncologists are still actively seeking novel treatment opportunities. For instance, in a recent survey, 50% of oncologists said they would pursue beyond the label usage of a therapeutic that matched the patient’s biomarker results, for instance EGFR mutation.
Data illiquidity adds to the difficulties in making optimal decisions. Although 97 percent of oncology practices use EMRs, only 10% of practices had EMR interoperability with hospitals in 2018, down from about a third in 2016. The gap creates challenges for implementing learning algorithms for the best care. Additionally, oncologists are increasingly open to automated analytics, with about a third using physician-decision support (PDS) tools. Still, the report showed oncologists remained isolated from the clinical flow of information, with fewer than one in four oncologists that use PDS tools reporting access to a PDS system integrated with their EMRs.

Without EMR integration, oncologists face challenges that limit further adoption of PDS tools. Integration allows PDS tools to detect novel clinical signals and improve predictions using machine learning, a benefit greatly desired by oncologists. Integration also enables PDS applications to help oncologists visualise expected outcomes. In isolation, analytics can only deliver static results that are limited primarily to data from clinical trials with long periods needed to incorporate RWE. And finally, integration can help resolve data quality issues that plague PDS tools. Without it, patient data must often be entered repeatedly, adding to the burden on the practice and increasing the chances for data-entry and clinical errors and the risks of liability.

Practices also face a shift in patient channels, with younger oncologists opting for online patient portals and older ones relying on email. As portal use becomes more common, these online channels will become a rich source of patient response data, complementing EMRs. Portals are particularly well-suited for data analysis and learning algorithms at scale.

This growing wealth of information provides new opportunities to create evidence-based treatment options. For example, panels that produce additional data over genotyping assays would be useful for exploratory understanding of disease mechanisms. Integration with EMR and communication portals would define machine learning approaches to predict patient response. And patient-provider communications would enrich the biological and clinical data needed to understand real-time patient outcomes.

Of course, automated decision-support analytics tools bring challenges as well as opportunities. PDS tools cannot be interpreted as recommending a therapeutic course that has not received FDA support. On the other hand, clearly linking available therapeutic options and biomarker results expands the options for life-saving therapeutic usage as clinical science and regulatory submissions catch up.

**Teaching machines to learn from oncologists**

Data-driven decisions can improve the outcomes for oncology patients, and to deliver these benefits quickly the broad oncology community should work together. Four measures in particular could prove very powerful.
Use biomarker data appropriately and transparently

Biomarkers have been at the forefront of oncology research and development and are expected to become requisites for the field. Combining biomarker data with clinical information in EMRs would identify complex genetic signatures linked to patient responses. Ultimately, larger sample sizes will produce phase IV-quality data and enable algorithms to be trained in a patient-care setting, with results that can be submitted to regulatory agencies and payers.

Rigorous, yet practical methods and practices are needed to define and standardise the collection, analysis, and reporting of real-world biomarker data. Today, many RWE analytics are strictly retrospective and observational, both of which are problematic. Further, any recommended decisions must be susceptible to robust analytics to confirm that data methods eliminated biases, controlled for quality, and allowed for the appropriate incorporation of disparate data sources. In addition, patient data collection, storage, and use must comply with increasingly stringent data privacy laws, such as the Health Insurance Portability and Accountability Act (HIPAA) in the United States and the General Data Protection Regulation (GDPR) in the European Union.

Integrate oncology decision support with the EMR

A range of capabilities will be needed to build a broader analytics platform that integrates oncology decision support with EMRs, crucially real-time data ingestion. Clinical data must be scrutinised through Health Level Seven International (HL7)-compliant interfaces and EMR-specific applications. Integration would reduce or eliminate redundant data entry and provide up-to-date information and knowledge for decisions.

At present, several burgeoning Fast Healthcare Interoperability Resources (FHIR)-enabled tools link to EMRs. Researchers at the University of Washington and Vanderbilt University, among others, are designing applications to visualise genomic information in real-time, using the FHIR standard to interface with data in EMRs. Early tools can already compare a patient’s genome against a distribution of thousands of other patients with links to external databases.

Oncologists will also demand that insights are displayed intuitively through effective visualisation in the EMR. The ability to visualise a patient’s expected clinical outcome for a certain therapy based on clinical trial RWE data is of great interest, with 74% and 73%, respectively, of oncologists rating the two features as very important. Not only will this enable clearer interpretation of results, it also minimises disruption to workflow, avoiding “click fatigue” as oncologists deal with a wealth of information on their screens.

Extract meaningful data from patient-provider communications

Portals can be powerful data tools when linked to physician-decision support algorithms. Yet similar to EMR data, data from portals would require interface between communications and the PDS. Additionally, well-designed natural language processing (NLP) tools would be needed to extract meaningful data from conversations. Once successful, a range of rich data would be available, including changes in regimen, medication adherence, patient engagement, adverse effects, and qualitative therapeutic benefit.
Link data-driven systems to post-approval monitoring and payer reimbursement

Decision-support systems tied to the EMR should not only support medical decisions, but also track the efficacy and safety of mass-produced therapeutics in the real world. New product introductions are increasingly complicated, featuring everything from more diverse usage patterns for patients and providers through drug-device combinations to advanced coating materials. Over the past two years, multiple studies have questioned the long-term impact of therapeutics on real-world quality-of-life and survival outcomes. Drugs passed by the FDA and European Medicines Agency were shown to have little follow-up once approved. These studies had clear limitations but highlighted the need for continued monitoring of approved medicines.

In addition, MCOs can link reimbursement processes to metrics tracked by a data-driven system in oncology. This would allow MCOs to manage costs amid a proliferation of treatment options for many indications with no clear leader. For instance, about 60% of projected haematology-oncology growth will come from classes with a high or medium degree of interchangeability. Decision-support solutions could also be linked to quality improvement programmes, documenting response to therapeutics – including patient compliance, appropriate drug utilisation, and support for the Healthcare Effectiveness Data and Information Set (HEDIS) of the US National Committee for Quality Assurance (NCQA) – with enhanced sensitivity and accuracy.

Embracing these measures will unlock a new era in patient outcomes, enabling oncologists to effectively analyse and deploy the rising abundance of therapeutics, technology, and data in breakthrough cancer treatment.

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