Impactful analytics: MD Anderson Cancer Center’s drive for better insights

MD Anderson’s transition to a next-generation data environment

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Summary

Catalyst

MD Anderson Cancer Center is an organization with a history of using data and intelligence as a strategic asset. Its highly evolved research and data-science culture and activity has been integral to progress in cancer care and in attracting both private and public funding. It had plenty of advanced BI users working with custom and COTS analytics applications and tools.

Despite this, by 2012, the organization had reached a tipping point. It suffered from the typical analytics challenges of a large healthcare enterprise, with a siloed data environment that had developed organically with lots of customization. Limiting factors included significant staff time on low-value work such as data cleansing, performance and integration challenges, and poor potential for big data analytics. Maintaining the status quo was no longer an option. It had to address the increasing volume and variety of data, which did not fit within traditional data models, such as incorporating unstructured and genomic data for critical projects like Moonshots, its program to radically change the way cancer is diagnosed and treated.

Its solution was to implement a step-change analytics program called FIRE (Federated Information Reporting Environment), incorporating technology investment, new data architecture, and organizational change. FIRE has delivered promising early results in both IT/analytics and clinical/operational domains.

Ovum view

At a fundamental level, MD Anderson’s experience shows how addressing the analytics iceberg – the far less “sexy” issues of data quality, aggregation, and processing – is integral to creating a viable analytics environment for the long term. The benefits of creating a modern analytics platform have been both operational and strategic: Automation and standardization has freed staff from laborious data preparation, speeding up time to value; and the transition to a new data model means it can incorporate multiple forms of structured, semi-structured, and unstructured data for more sophisticated and granular analysis.

Achieving this requires organizations to take a step back and ensure they take an enterprise-wide, rather than departmental, approach towards analytics. The FIRE program highlights how the shift to a data environment capable of processing all data types (clinical, genomic, financial, operational, etc.) and data formats (structured, unstructured, etc.) requires fresh approaches to enterprise data architecture. Other stand-out factors are:

- MD Anderson’s intelligent and iterative approach to a complex program. This enabled it to work through teething problems, demonstrate early wins, and hammer out solutions to product/integration challenges.
- A high awareness of the strategic value of data at a clinical and informatics level, which underpinned the creation and direction of FIRE.
- The choice of a product stack as opposed to a custom development, commensurate with the growth of COTS analytics solutions within healthcare.
Many healthcare organizations, particularly those in the public sector, are struggling with limited capex IT project funding and competing IT investment priorities. Yet, although MD Anderson may be in a minority (a fast-growing, well-funded leader in the prominent field of oncology), its analytics journey still holds salient lessons for any mid- to large-sized healthcare organization struggling to extract value from healthcare data.

Key messages

- Large, data-intensive healthcare organizations need to take an enterprise-wide approach to prepare for next-generation analytics. This is a challenging journey, not a finite project.
- Well-implemented next-generation analytics programs can deliver substantial benefits in clinical informatics, data analysis, and operations.
- Senior-level clinical informatics buy-in is essential in ensuring enterprise-wide support and input.
- An enterprise-wide program with executive support provides an opportunity to rethink overall data architecture and explore new approaches.
- Large-scale analytics change requires iterative development to showcase a staggered ROI and incorporate agile development methodologies.
- Achieving the right balance between analytics standardization and departmental autonomy is challenging but critical.
- Organizations should address data governance and MDM issues early and not underestimate the work entailed.
- Enterprises can benefit from the pre-built and healthcare specific features available in next-generation healthcare analytics solutions, but they can be complex to implement.
- Self-service analytics tools are integral to creating a strong enterprise-wide analytics environment.

Recommendations for healthcare enterprises

Savvy healthcare organizations can benefit significantly from standardization, but it should enable rather than limit analytics innovation

There are lots of organizations with an established use of analytics by power users across multiple departments. In most cases though, activity has developed in an organic, highly federated manner. There is significant value in automating the “commodity” data work undertaken by teams and increasing consistency by standardizing around clinical codes and data models where it makes sense. It is also important for organizations to support, not stifle, innovative “analytics freedom” and help democratize the use of analytics by the smart use of self-service analytics dashboard tools. This applies in analytics across the organizations including those involved in more exploratory work in areas such as medical research and population health.
Clinical leadership ensures enterprise-wide analytics is regarded as mission-critical rather than an “IT project”

MD Anderson’s FIRE program is driven by its Clinical Analytics and Informatics (CAI) team. The team is closely aligned to all lines of activity – clinical, research, operational and financial analysis requirements – and new strategic programs. Enterprise-wide analytics programs which do not effectively engage with clinicians and teams working in informatics analytics projects are likely to fail.

Analytics programs are an opportunity for improving data governance: Address this early on

The reality is that data governance is usually an afterthought or a knee-jerk reaction to an incident. MD Anderson’s experience shows that analytics programs are a great opportunity for improving data quality, processes, and data governance. It also highlights the importance of assigning a data governance manager at the start of any work or at least ensuring a senior team member has responsibility for data governance. Analytics without strong data quality is akin to trying to build a house on shaky foundations.

Take advantage of maturing next-generation healthcare analytics solutions, but be mindful of your capabilities and wider data needs

MD Anderson wanted to ensure it could handle both more structured clinical data and other forms, including unstructured and imaging data. Analytic solutions tailored to healthcare are rapidly maturing with pre-built models designed to accommodate specific healthcare data types and a growing array of advanced tools; for example, in data integration. However, they can often be complex to implement and require new skills and knowledge, particularly for multiple use cases and implementation at scale. Healthcare organizations should carefully assess their internal capabilities and the support vendors offer for customization in order to accurately gauge the cost and challenge of implementation. Partners with local support also play a critical role.

Essential factors and lessons learned

Table 1 lists the essential characteristics and key factors for the FIRE (Federated Information Reporting Environment) program across the five domains critical to analytics deployments. The five domains are: business case; resourcing and project management; data; technology; and organizational readiness (actionable).

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<thead>
<tr>
<th>Domain</th>
<th>Key characteristics</th>
<th>Highlights and challenges</th>
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<tbody>
<tr>
<td>Business case</td>
<td>Data-intensive organization with a history of differentiation via leading-edge research</td>
<td>Early use case to demonstrate ROI/benefits critical to securing ongoing executive support</td>
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<td>Field</td>
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<td>Impactful analytics:</td>
<td>MD Anderson Cancer Center's drive for better insights</td>
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<tr>
<td>Executive support</td>
<td>Positioned as an iterative program designed to operate indefinitely as a central platform for data analytics activity within MD Anderson. Executive support, initially driven by Chief Medical Information Officer (CMIO) for capital investment program.</td>
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<tr>
<td>Cost</td>
<td>A rough estimate of the cost to date is around $7m (from program start in 2Q12 to 2Q15). The second year cost of $3m included significant investment in hardware (e.g. Exadata servers).</td>
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<tr>
<td>Resourcing and project management</td>
<td>Managed out of the Clinical Analytics and Informatics department (CAI). Multiple work streams with teams consisting of: project manager; business analyst (from individual departments); data modeler; integration developer; BI solutions developer. Formed a separate governance team within FIRE 18 months ago.</td>
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<tr>
<td>Data</td>
<td>Custom EHR, migrating to Epic. FIRE has involved greater standardization around codes.</td>
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<tr>
<td>Pragmatic project management</td>
<td>Pragmatic project management approach using iterative development based on Scrum. Program team structure evolved significantly as project progressed with particular emphasis on data governance and departmental representation.</td>
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<tr>
<td>RUNNING COSTS WILL BE LOWER</td>
<td>While running costs will be lower compared with the implementation phase, the team anticipates increased analytics activity in line with FIRE's role as the organization's main analytics platform.</td>
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<td>Team</td>
<td>Started with one work stream and has expanded, currently there are 3-4 concurrent work streams. The appointment of a data governance manager was an important addition to the team and something which the team would have found value in from the outset. Also have technical data governance &quot;coordinators&quot; managing master data management (MDM) and metadata management tools.</td>
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## Impactful analytics: MD Anderson Cancer Center’s drive for better insights

<table>
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<th>Actionable</th>
<th>Technology</th>
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<tbody>
<tr>
<td>Active culture of analytics users with domain expertise</td>
<td>Oracle EHA solution, Oracle TRC, Oracle DB, Oracle Exadata, OBIEE, Informatica (ETL tool)</td>
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<tr>
<td>Understanding of the criticality of data within existing user groups</td>
<td>SAP (Lumira, Business Objects), Tableau</td>
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<tr>
<td>Relatively mature digital data environment</td>
<td>IBM content analytics and other NLP tools</td>
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<tr>
<td></td>
<td>Work with some governance tools</td>
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<tr>
<td></td>
<td>Proof of concept with Hadoop</td>
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<tr>
<td></td>
<td>Features to support ETL play an important role</td>
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<tr>
<td></td>
<td>Healthcare domain specific aspects such as pre-loaded data/terminology/language are key</td>
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<tr>
<td></td>
<td>Growing assimilation of unstructured data</td>
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<tr>
<td></td>
<td>Assessing big data technology roadmap; for example, it has a proof of concept running with Hadoop</td>
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</tbody>
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There are 38 source systems connected to the data warehouse, which incorporate:
- clinical (e.g. patient demographics and diagnosis);
- operational (e.g. pharmacy, employee);
- genomic and unstructured data (e.g. NLP, comorbidities, and vcf and cnv files)

Some common data types (e.g. specimen data) fed in from multiple source systems

7-8 terabytes of data within a single instance of the data warehouse, this is growing

Incorporates over 300 million lab results and has around 12,000 genomic VCF files

The scale of patient data volume is underlined by number of patient records (1.1 million), with certain data elements dating back to 1944

FIRE has improved data transparency

Incorporation of unstructured data is critical to improving granularity of insights

Roadmap for inclusion of other data (e.g. social media)
Moonshots program designed to explicitly exploit big data/complex analytics (on Apollo platform)

Over the past year, it has been working with the compliance team to determine what processes and governance can be applied to data as it is ingested into the warehouse to incorporate protection for PHI data and autonomy for different user groups with self-service BI playing an important role

Will improve training for growing number of users by using video material for basic induction

Further work in using insights to directly impact change/ care. This should become easier through a combination of the new organizational wide EHR (Epic) and analytics

As the number of users increase, establishing effective role-based access is critical to meet compliance requirement. This is not a small undertaking

Source: Ovum/MD Anderson

Lessons learnt

Taking the long view: Clinical leadership is critical

There are two critical factors underpinning the FIRE program. Firstly, it was never envisaged as a one-off project. MD Anderson realized that the existing status quo was unsustainable in terms of both effectively reacting to data challenges (volume increase, the need for more veracity, and the growing significance of unstructured data) and in proactively making the most of the large-scale, rich datasets housed internally and increasingly accessible externally. This made it necessary to create a platform which would be capable of supporting evolving data and analytics needs over the long term.

Secondly, the driving force behind FIRE was clinical leadership, with the Chief Medical Information Officer (CMIO) making the initial case for the program. Today it has the support of a broader range of executives including the CIO and other senior leadership. This was important in ensuring clinical relevance and user focus, and in building the business case at an organization that differentiates itself in particular by the cutting-edge nature of its medical expertise.

Right-sizing the project management approach and methodologies to support the business case and effective governance

Reaching agreement on the scope of the program and refining the details was a challenging and time-consuming process and FIRE went through a number of different iterations. The project owners were mindful of the importance of generating tangible outcomes early on. In this respect, adopting a waterfall project management approach was not suitable, but did the team not want to operate in a purely agile environment. A more pragmatic, hybrid approach was taken with iterative development using Scrum in order to ensure they could deliver early results.
Another important aspect is the extent to which FIRE has strong governance and management controls in place, particularly important in dealing with significant volumes of personal healthcare information (PHI) data. Just as the project team struck a balanced approach to implementation, it has maintained strong ongoing program management. An internal IT audit carried out in 3Q14 found that “the Clinical Analytics and Informatics has a strong control environment with many control processes related to security, change management, and computer operations.”

**Vendor relationship with strong partnership status**

MD Anderson’s solid relationship with Oracle certainly played a role in the success of the project. The organization describes it as more of a co-collaboration approach around FIRE whereby they were able to feedback on areas for improvement within the product. While MD Anderson’s position as an Oracle strategic partner has certainly helped to ensure more direct access to senior Oracle healthcare expertise, the team was also impressed by the comprehensiveness of the EHA portfolio and the vendor’s domain expertise.

**Individual early wins are important in seeding support and showing tangible benefits**

Early wins were critical to building confidence in the project at an executive board level. Throughout the build-out of the program, and now on an ongoing basis, the team regularly tracks tangible and intangible ROI. Arguably, it also helps to educate non-technical leaders on the importance of technology. For example, the focus on getting the pharmacy project up and running within a year prompted the president of MD Anderson to call the combination of Cohort Explorer with ODB a “game-changer.”

**A flexible but strong framework to accommodate improvement and change is essential**

MD Anderson quickly learnt from mistakes and experience and adapted not only technology and data model architecture, but also the overall FIRE program team structure. This was critical to ensuring the program stayed on track and relevant.

**Analytics on FIRE: MD Anderson’s enterprise-wide program**

**Healthcare enterprise context**

**Improving the quality and efficiency of patient care and cancer research**

Globally, there are a handful of large, high-profile institutions specializing in the treatment of cancer and in research designed to improve the quality of care, diagnosis, and treatment. These institutions handle large amounts of clinical, research, and – increasingly – genomic data. They tend to have a large number of diverse data users ranging from data scientists to clinicians and medical researchers. They are heavily involved in the development of “precision medicine,” tailoring cancer drugs and treatment plans to individual patient characteristics, including genomic traits.
MD Anderson seeks to build on its position as one of the leading global oncology institutions

The University of Texas MD Anderson Cancer Center, based in Houston on the Texas Medical Center Campus, is a well-known organization active in the care, research, education, and prevention of cancer. It is one of the three original comprehensive cancer centers in the US designated by the National Cancer Act of 1971. It is also one of the largest in the world, with revenues of $4.4bn in 2014, and is growing rapidly. In 2014, it invested more than $735m in research, an increase of 35% over the last five years and is expanding its portfolio of research activity and the MD Anderson Cancer Center Care Network to new locations.

Cancer at the nexus of insights derived from little and large data

A core goal is to accelerate and improve the translation of scientific knowledge into clinical care. The effective use of data and technology is integral to this mission and will become more so with the advent of programs like Moonshots, designed to personalize and optimize treatment by incorporating genomic data. MD Anderson faces mounting pressure to sustain more complex and new forms of research while increasingly “operationalizing intelligence” for better care. In this respect, the extent to which it can use its own and third-party data will become more critical in the future. These combined factors prompted the organization to take a long, hard look at its overall data and analytics environment.

Step-change: Transitioning to an enterprise-wide analytics strategy and data environment

A complex, highly federated, and relatively unmanaged data analytics scenario

MD Anderson information users had been working in a highly federated data environment characterized by:

- A number of analytics implementations across multiple departments
- Significant variation in the types and quality of data, some of which was intrinsic to the data, some of which was due to poor data quality
- Lengthy and resource-intensive processes for data extraction, cleansing, and aggregation by staff working within IT and research departments
- A variety of user groups ranging from clinicians to researchers
- Limited scope for clinical analytics outside their internally developed EHR, with data aggregation for patient-care clinical use in single UI by an SOA-based custom .NET application
- Substantial growth in data volumes; between 30–40% annually in recent years.

MD Anderson launched FIRE (Federated Institutional Reporting Environment), a multimillion dollar capital investment program led by the Clinical Analytics and Informatics department (CAI), to facilitate a step-change to the organization’s underlying data foundations/architecture. The team wanted to both improve the overall data and analytics environment today and prepare for better and more pervasive use of analytics in the future including, notably, mining unstructured data. This aim translated into three main goals:

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- Create a comprehensive centralized clinical data repository supporting clinical/institutional analytics, decision making, and business intelligence needs
- Develop a central repository for historical and operational data
- Break down data silos.

FIRE was also intended to support and integrate with the Moonshots program in the following ways:
- Gene-sequencing results from Moonshots are loaded into the data warehouse; FIRE provides a standard format which enables this loading
- Provides the framework for aggregating clinical medicine and genomic research.

**FIRE program development**

**Core technology**

MD Anderson selected the Oracle Enterprise Health Analytics (EHA) stack and Informatica PowerCenter for ETL. The main products for the FIRE platform are:
- Oracle Healthcare Data Warehouse Foundation (HDWF)
- Oracle Healthcare Analytics Data Integration (OHADI), including the OHADI application toolkit
- Oracle ExaData
- Oracle Database
- Oracle Business Intelligence Enterprise Edition (OBIEE).

The team is also using Oracle Translational Research Center (TRC) Cohort Explorer and Oracle TRC Omics Data Bank (ODB).

**Program management and timeline: Lots of change and partner support is critical**

Figure 1 shows the phased introduction of functionality for FIRE. MD Anderson purchased OHDWF and OHADI in May 2012, had three months implementation, and then the team went to production successfully with the first FIRE release in November 2012, starting with the pharmacy dashboard. They worked with Oracle’s health sciences experts. The organization also stressed the importance of local SI support.

**Figure 1: FIRE program timeline**

Source: MD Anderson/Ovum
Technology and architectural highlights

The FIRE program was complex and involved a number of different projects and products. Over the course of the initial implementation, multiple changes were made including perfecting the overall program team structure and architectural approaches as learnings and challenges emerged. The team sought to maximize the benefit of both the EHA solution and the wider use of Oracle data infrastructure, by designing a logical and practical architecture which could accommodate data complexity and also evolve with time.

Figure 2: FIRE physical architecture

Architecture and technology strategy lessons

- **Data transition/integration.** A key challenge was finding a viable way to move data into the Healthcare Data Warehouse Foundation (HDWF) and deliver it to custom data marts. MD Anderson’s approach was to bring all the data processing together on a single Oracle instance to derive performance benefits from local movement and transformation. The next step was abstracting across all commonalities and patterns to the largest extent possible, avoiding needless one-off solutions, using code generation and automation, with a view to using Exadata at a later stage. Oracle’s EHA includes source-system-friendly interfaces that allow for easier mapping and management of disparate types of source data into the EHA-based FIRE environment.

- **Vocabulary/terminology.** A notable goal was, where possible, to reduce data variation and exploit codes like SNOMED and ICD-10 more fully. In this respect, some of Oracle’s pre-built EHA aspects were highly pertinent, such as controlled vocabularies, seeded terminologies, and the logical and physical models within EHA which are specific to healthcare terminology and vocabulary. MD Anderson stressed the importance of having a good vocabulary/terminology approach in place to help with code system implementation in the model.

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**Pre-built benefits/ customization balance.** The use of a productized warehouse model in EHA helps to avoid complexity and time required to develop intermediary models and enforcement of standards. While the tables cover significant number of clinical/ genomics/ financial/ operational concepts, they may require some customization; in this instance, the Oracle products support extensibility solutions.

**Pre-built loaders and data management features** for clinical, operational, financial, and genomic data that also deal with data-quality validation and terminology standardization via Oracle’s OHADI and ODB loaders.

**Complex queries/Exadata benefit.** The queries on ODB and CDM were often challenging given the size and volumes of OMICS data and Exadata helped substantially from a performance perspective.

*Front-end analytics/ dashboard environment*

All operational, clinical, research, and genomic data now resides within the FIRE platform, which is managed by a central IT team working with different departments. Critically, MD Anderson has also incorporated unstructured data into analytics, creating an algorithm to mine data for important medical nuances contained in doctors’ unstructured notes, for example, on patient reactions to treatment. FIRE now generates multiple ad-hoc reports for a broad variety of users. Departmental teams at MD Anderson work with multiple third-party and custom dashboard applications. These include:

- Oracle Cohort Explorer. Used for ad-hoc exploration of patient populations. Used primarily by the Pharmacy, Genomic Medicine, and Clinical Analytics and Informatics (CAI) departments with approximately 70 users.
- Pharmacy dashboards in OBIEE. These enable users to compare and analyze drug sales and dispense data.
- Third-party applications SAP (Lumiera and Business Objects), Tableau.

**FIRE roadmap: Outcomes and next steps**

**Promising early benefits**

The impact of FIRE breaks down into tangible and less tangible benefits. Some of these are directly related to front-line operations, while some are relevant to IT & analytics activity and research quality and innovation. To date, the main benefits are as follows:

**Improved pharmacy inventory management and prescribing**

Due to a phased implementation of FIRE, MD Anderson was able to generate early benefits related to its drug/pharmacy activities. Pharmacy Explorer enabled staff to compare drugs from different classes to identify usage and optimize both inventory management and prescribing.

**Less time-consuming commodity work; more insight**

MD Anderson is a research-heavy organization with a large headcount and high spending on R&D. FIRE’s benefits were quickly evident as the amount of time staff spent assembling data for analysis was reduced from weeks to minutes. This applied to both researchers and administrative staff.
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Data quality improvement and re-use
The process of data aggregation and integration enabled MD Anderson to identify poor-quality data and take action.

Enabling analytics innovation for advanced clinical decision support
FIRE provides part of the foundation for MD Anderson's adaptive learning "Apollo" platform, which supports the Moonshots program. Apollo also uses IBM Watson and NextBio/Alumnia. An early success has been a significant increase in the rate of complete surgical removal of patients' tumors from 25% to more than 80% by using an algorithm which determines when ovarian cancer patients should have surgery.

Ready to go: Creating an analytics-ready organization
FIRE has enabled MD Anderson to aggregate and mine clinical, operational genomic, and new forms of data like social media. The organization will now drive analytics on two fronts: improving research and business intelligence; and embedding these insights into front-line operations and care. The critical point about FIRE is that it is enabling the inclusion of real-world and unstructured data within analytics, something which would have been hugely difficult – in some cases impossible – previously. While some necessary autonomy over analytics applications and dashboard tools remains for individual teams, FIRE has also helped to create a more joined-up culture and approach towards data and analytics within the organization.

Next steps
Embedding insights into care and process improvement
A key focus going forward will be to look at how the organization can further operationalize insights across activities; for example, in improving diagnosis and treatment plans and optimizing supply chain management.

Marrying analytics with Epic implementation
MD Anderson expects that the organization-wide standardization around its forthcoming Epic implementation will make embedding analytics into point of care an easier process, although it acknowledges that, at this stage, the extent to which this is feasible is not clear.

Incorporating little and large data into analytics
With FIRE in place, MD Anderson is in a position to start expanding the amount of little and large data, such as social media data, unstructured text, and "omics," it can assimilate for analysis. The next steps are to assess how it might incorporate existing big data technologies like Hadoop and newer technology on the horizon for wider enterprise usage.

Maturing analytics activity within departmental opex
While the FIRE program is run out of the central CAI department, MD Anderson will also explore possible options for operationalizing and federating some of the cost and work within individual departments as analytics use becomes more pervasive within the organization.
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Appendix

Methodology

This case study is based on interviews with MD Anderson and Oracle and secondary published research.

Further reading

The Case for Making Analytics a First-Class Citizen in Healthcare, IT0011-000339 (January 2015)
2015 Trends to Watch: Healthcare Technology, IT0011-000328 (November 2014)
“Making analytics a first-class healthcare citizen: lessons from Oracle customers”, IT0011-000335 (November 2014)
A Practitioner's Guide to Self-Service BI and Analytics, IT0014-002967 (December 2014)
2015 Trends to Watch: Business Intelligence and Enterprise Performance Management, IT0014-002945 (October 2014)

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