Transforming the Business of Oncology through Science and Technology
Big Data Platforms to Support Community Oncology

Moderator
Carla Balch, President, NantCare

Panelists
James Hamrick, M.D., Senior Medical Director, Flatiron Health
Debra Patt, M.D., M.P.H., M.B.A., Vice President, Texas Oncology
Robert S. Miller, M.D., Vice President & Medical Director, CancerLinQ
Vasu Rangadass, Ph.D., Chief Strategy Officer, NantHealth
Big Data Platforms to Support Community Oncology

James Hamrick, M.D.
Senior Medical Director,
Flatiron Health
Standardize EHR data to a common data model

- Demographics
- Diagnosis
- Visits
- Labs
- Therapies

Structured Data

Unstructured Data

Structured Data Processing

Real-World Database

Unstructured Data Processing

Physician Notes

Radiology Report

Pathology Report

Discharge Notes

Outside Practice

Hospital

Lab
Organize datasets for analysis

- Patient age
- Gender
- Race
- Insurance
- TNM staging
- Comorbidities

- Date of surgery
- Sites of metastases
- Time to recurrence

- Regimen name
- Duration of therapy
- Dosage
- Concomitant meds
- Response
- Reason for discontinuation

- Biopsy date
- Lab name
- Test result
- T790M mutation

- Date of death
- Date of death
- Consensus date of death

Datasets linked & organized

<table>
<thead>
<tr>
<th>Structured EHR data</th>
</tr>
</thead>
<tbody>
<tr>
<td>Unstructured EHR data</td>
</tr>
<tr>
<td>External Mortality data</td>
</tr>
<tr>
<td>Combined/Derived data</td>
</tr>
<tr>
<td>Claims data</td>
</tr>
</tbody>
</table>

Diagnosed with Stage II NSCLC
Undergoes surgery for early-stage disease
Develops metastatic disease
Tested for EGFR and ALK
Starts 1L therapy
Progresses on 1L, tested for PD-L1 and/or re-tested for EGFR
Starts 2L therapy, deteriorates and is hospitalized
Death

Diagnosed with Stage II NSCLC
Develops metastatic disease
Tests for EGFR and ALK
Starts 1L therapy
Progresses on 1L, tested for PD-L1 and/or re-tested for EGFR
Starts 2L therapy, deteriorates and is hospitalized
Death
Organize datasets for analysis

Example: Non-small cell lung cancer
Link processed EHR data to other datasets

Processed structured & unstructured EHR data

- External mortality datasets
- Germline & somatic genomic data
- Claims data
- Prospective data capture
- Patient-reported outcomes
- Biosensors
RWE along the continuum

Clinical Practice → REAL-WORLD DATA → Clinical Trial Dataset

Retrospective RWE

Prospective RWE

Retrospective Capture with Longitudinal Follow-Up → Prospective Capture

Consent with or without randomization

- Identification of rare patients
- Observational data on off-label use
- Real-world follow-up on clinical outcomes
- Pragmatic trial

2017 Cancer Center Business Summit
<table>
<thead>
<tr>
<th>Description</th>
<th>N</th>
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</thead>
<tbody>
<tr>
<td>Evidence of lung cancer diagnosis (ICD code) and at least two visits at a</td>
<td>55,975</td>
</tr>
<tr>
<td>community practice in the Flatiron network after 1/1/2011</td>
<td></td>
</tr>
<tr>
<td>Clinical confirmation of non-small cell lung cancer (NSCLC) based on review</td>
<td>23,319</td>
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<tr>
<td>of unstructured documents</td>
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<tr>
<td>Clinical confirmation of advanced NSCLC (diagnosed stage IIIB - IV) or</td>
<td></td>
</tr>
<tr>
<td>diagnosed early stage and developed advanced disease</td>
<td>1,578</td>
</tr>
<tr>
<td>Diagnosis of advanced NSCLC on or after 1/1/2011</td>
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</tr>
<tr>
<td>Completeness of record: Less than a 90 day gap between advanced diagnosis</td>
<td></td>
</tr>
<tr>
<td>date and structured first activity date</td>
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</tr>
<tr>
<td>Usage of a PD-1 inhibitor: Order or administration of nivolumab or</td>
<td></td>
</tr>
<tr>
<td>pembrolizumab</td>
<td></td>
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<tr>
<td>Final cohort</td>
<td></td>
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</table>

N = Number
Comparison of PD-1 treated patients in Flatiron dataset to clinical trials

<table>
<thead>
<tr>
<th>Age - yr</th>
<th>Nivo (N = 292)*</th>
<th>Pembro (N = 498)**</th>
<th>Flatiron (N = 1576)</th>
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<tbody>
<tr>
<td>Median</td>
<td>61</td>
<td>64</td>
<td>69.2</td>
</tr>
<tr>
<td>Range</td>
<td>37-84</td>
<td>28-93</td>
<td>32 - 85+</td>
</tr>
<tr>
<td>Age &gt;= 75 yr - no. (%)</td>
<td>20 (7)</td>
<td>Not reported</td>
<td>430 (27%)</td>
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<tr>
<td>Male sex - no. (%)</td>
<td>151 (52)</td>
<td>261 (53)</td>
<td>885 (56)</td>
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<tr>
<td>Race/ethnicity - no. (%)</td>
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<td></td>
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</tr>
<tr>
<td>White</td>
<td>267 (91)</td>
<td>406 (82)</td>
<td>1084 (69)</td>
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<tr>
<td>Asian</td>
<td>9 (3)</td>
<td>64 (13)</td>
<td>4 (3)</td>
</tr>
<tr>
<td>Black</td>
<td>7 (2)</td>
<td>20 (4)</td>
<td>89 (6)</td>
</tr>
<tr>
<td>Hispanic or Latino</td>
<td>Not reported</td>
<td>Not reported</td>
<td>46 (3)</td>
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<tr>
<td>Other</td>
<td>9 (3)</td>
<td>5 (1)</td>
<td>102 (6)</td>
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<tr>
<td>Unknown / Missing</td>
<td>0</td>
<td>0</td>
<td>213 (14)</td>
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<tr>
<td>Smoking status - no. (%)</td>
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<tr>
<td>Current or former smoker</td>
<td>231 (79)</td>
<td>369 (75)</td>
<td>1396 (89)</td>
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<tr>
<td>Never smoked</td>
<td>58 (20)</td>
<td>126 (25)</td>
<td>169 (11)</td>
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<tr>
<td>Unknown</td>
<td>3 (1)</td>
<td>-</td>
<td>13 (1)</td>
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<tr>
<td>Histology - no. (%)</td>
<td></td>
<td></td>
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<tr>
<td>Squamous</td>
<td>-</td>
<td>85 (17)</td>
<td>560 (36)</td>
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<tr>
<td>Nonsquamous</td>
<td>100%</td>
<td>401 (81)</td>
<td>967 (61)</td>
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<tr>
<td>Adenosquamous</td>
<td>-</td>
<td>7 (1)</td>
<td>-</td>
</tr>
<tr>
<td>Unknown</td>
<td>-</td>
<td>2 (0.4)</td>
<td>51 (3)</td>
</tr>
<tr>
<td>EGFR status - no. (%)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Tested</td>
<td>Not reported</td>
<td>478 (97)</td>
<td>999 (63)</td>
</tr>
<tr>
<td>Mutated (% of tested)</td>
<td>44</td>
<td>74 (16)</td>
<td>79 (8)</td>
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<tr>
<td>ALK status - no. (%)</td>
<td></td>
<td></td>
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<tr>
<td>Tested</td>
<td>Not reported</td>
<td>438 (88)</td>
<td>945 (60)</td>
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<tr>
<td>Translocated (% of tested)</td>
<td>13</td>
<td>9 (2)</td>
<td>16 (2)</td>
</tr>
<tr>
<td>KRAS status - no. (%)</td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>Tested</td>
<td>Not reported</td>
<td>295 (60)</td>
<td>368 (23)</td>
</tr>
<tr>
<td>Mutated (% of tested)</td>
<td>28</td>
<td>77 (26)</td>
<td>114 (31)</td>
</tr>
</tbody>
</table>


Transforming the Business of Oncology through Science and Technology
Big Data Platforms to support Community Oncology

Debra Patt, MD MPH MBA
Vice President, Texas Oncology

Disclosure: I will discuss some data systems and pilots managed by US Oncology and McKesson Specialty Health where I serve as the medical director for analytics. I will discuss JCO-CCI where I serve as the Editor in Chief.
BIG IDEAS: Greater efficiency, better care, integrating into clinical workflow with knowledge of operations and systems of delivery
Big Data Platforms help Community Oncology

- Close gaps in care using Telemedicine
  - Expertise
  - Geography
  - Social determinants of health
- Enhance research opportunities using data systems
  - Just in time enrollment
  - Remote screening
- Facilitate evidence based care
  - Clinical decision support systems
- Better evaluate risk
  - Predictive analytics
Telemedicine Platforms Close Gaps in Care

- Leverage expertise over greater geography
- Provide access to services unavailable in certain sites of service
- Enhance the continuum of services provided in each location
Remote Consultation for Proton Therapy, Genetics Risk, Neuro Oncology, Palliative Medicine
Enhance Research Opportunities by using data to enhance access

- Electronic Health Record Systems that can be used for clinical trial screening
- Just-in-time accrual protocols for rare tumor types and molecular mechanisms
Our value: **Efficient Activation of Sites as Patients are Identified**

- **Number of STAR studies to date:** 50
- **Total Count of Patients Enrolled:** 507
- **Average Patients Enrolled per Study:** 10
- **Average Start Up:** 14 days
- **Activated a site in as little as 5 days**
- **Number of Sponsors to date:** 22
- **Number of CROs to date:** 12

Data as of 02SEP2016
CDSS Enhances Compliance with Guidelines

- Clinical Decision Support Systems
  - Pathways
  - Compliance with other quality programs

- Import Guidelines
- Improve efficiency with order entry
- Reduce error
- Facilitate compliance with guidelines
- Report performance back to physicians
Clear Value Plus brings additional information into iKnowMed

Clear Value Plus
• Extension of iKnowMed EHR
• Flexible access to leading content:
  • Value Pathways powered by NCCN
  • NCCN Guidelines
  • Clinical trials regimens
• Fast to use, simple to learn
• Real-time reporting on compliance, performance and outcomes
Value Pathways powered by NCCN: Leadership in evidence-based medicine

- Evidence-based protocols to reduce treatment variability, hospitalizations, and excessive care at the end of life
- Refinement of the NCCN Guidelines®
- Direct collaboration with NCCN physicians
- Selected based on efficacy, toxicity and cost

Accessible for physicians through Clear Value Plus™ technology
Predictive Analytics to Understand Risk

- Genomics
- Stage
- Socioeconomic Status
- Comorbidity
- Organ Function
- Recent Hospitalization
- Age
- Prior Therapy
- Vital Signs

Risk Modeling Prediction
Risk Factors

Study Name

- Age > 70
- Comorbid illness
- Stage IV
- Weight change
- Sodium change
- Anemia
- Performance status
- Overall: P < 0.001, I² = 73.1%

Graph Generated by DistillerSR
Predicting Risk

- Giving treatment teams risk scoring on high risk patients
- Allow them to intervene just in time
- 30 day hospitalization risk
The Promises of Big Data

• To make us more efficient and effective
• To enhance quality of patient care
• To close gaps in care we have today
• Not just meaningless data outputs, but to be integrated in the process workflow of patient care
Sharing information on how our data systems enhance care delivery will help us all get better faster
Big Data Platforms to Support Community Oncology

Robert S. Miller, MD, FACP, FASCO
Vice President and Medical Director, CancerLinQ
American Society of Clinical Oncology
Unlocking the Data

CancerLinQ will unlock a universe of practical insights to improve the care of every patient with cancer.

CLQ Quality Performance Indicators:
Real time clinical quality metrics, to prospectively identify opportunities to improve performance.

CLQ Insights: Uncover trends from the CLQ population that can improve quality of care provided to each patient.

Your Patient’s Timeline: Visual representation of clinical event history in a longitudinal view.

Powerful Analytic Reports: Quick observations to uncover insights about patient populations at a glance.
Big data platforms in oncology...

...the “V” challenges we all face:

- Volume: Millions of rows, thousands of columns exceed traditional relational db capacity → analytic challenges
- Variety: data types (structure, standardization, ontologies)
- Velocity: data refresh frequency (real-time, timeliness)
- Veracity: data quality (accuracy, completeness) ★
- Value: add-value of data (cost, workflow, feasibility, governance)
Artificial intelligence and oncology in pop health
Artificial intelligence in oncology and pop health

1. Machine learning
   a. Supervised – e.g., risk assessment, imaging analytics
   b. Unsupervised – e.g., GWAS

2. NLP (esp. extraction from clinical narratives)
   a. Clinical trials matching
   b. Cancer registry reporting
   c. Semantic enrichment of clinical documents for search

USE CASE: NLP-assisted human curation
Scatter plot of sensitivity or recall results reported for group 1 studies. (Studies using an existing classification, vocabulary, or terminology system)

Mary H Stanfill et al. A systematic literature review of automated clinical coding and classification systems. J Am Med Inform Assoc 2010;17:646-651
Real-World Evidence — What Is It and What Can It Tell Us?

Rachel E. Sherman, M.D., M.P.H., Steven A. Anderson, Ph.D., M.P.P.,
Gerald J. Dal Pan, M.D., M.H.S., Gerry W. Gray, Ph.D., Thomas Gross, M.D., M.P.H.,
Nina L. Hunter, Ph.D., Lisa LaVange, Ph.D., Danica Marinac-Dabic, M.D., Ph.D.,
Peter W. Marks, M.D., Ph.D., Melissa A. Robb, B.S.N., M.S., Jeffrey Shuren, M.D., J.D.,
Robert Temple, M.D., Janet Woodcock, M.D., Lilly Q. Yue, Ph.D., and Robert M. Califf, M.D.

Real World Evidence (RWE)

“The New England Journal of Medicine

Sounding Board

“Real-world evidence can inform therapeutic development, outcomes research, patient care, research on health care systems, quality improvement, safety surveillance, and well-controlled effectiveness studies. Real-world evidence can also provide information on how factors such as clinical setting and provider and health-system characteristics influence treatment effects and outcomes.”
Leadership & Management

MD Anderson to cut about 1,000 jobs

Written by Ayla Ellison (Twitter | Google+)  | January 05, 2017 | Print | Email

The University of Texas MD Anderson Cancer Center in Houston plans to eliminate about 1,000 jobs, or 5 percent of its 20,000-person workforce, as it tries to improve its financial health.

At a press conference Thursday, MD Anderson officials said between 800 and 900 workers will be laid off, and an additional 100 to 200 jobs will be cut through retirement and attrition, according to the Houston Business Journal. The job cuts will not affect any physicians.

"We primarily focused on those areas where we could make staff reductions, re-engineer administrative support, and not impact quality of patient care," officials said at the press conference, according to the report.

The job cuts are expected to save MD Anderson about $120 million a year.

MD Anderson is scaling back its workforce after it reported a combined $102 million operating loss in September and October and a $9 million operating loss in November. At the press conference Thursday, MD Anderson CFO Dan Fontaine said the organization likely does not have a positive operating margin for December, according to the report.

MD Anderson's financial troubles began in early 2016 when it rolled out a new Epic EHR system. The organization recorded a 76.9 percent drop in adjusted income for the 10 months that ended June 30, 2016, a downfall officials largely attributed to its EHR implementation project.

Despite its sputtering financials, MD Anderson officials said Thursday the organization's long-term financial health
Technology and oncology – what will the future hold?

1. Widespread data-sharing
2. Meaningful penetration of actionable oncology-specific mHealth technology
3. Real insights gleaned from unsupervised machine learning applied to NGS output (especially WES, WGS)
4. Big-data platforms supporting external compliance reporting (elimination of manual data abstraction for quality measurement)
5. RWE used in regulatory decisions (esp. label expansion)
6. Greater structured data capture in EHRs embedded in clinician workflows (culture change + tech solution)
Big Data Platforms to support Community Oncology

- Vasu Rangadass, Ph.D., Chief Strategy Officer, NantHealth
Improving Healthcare: Two Transformational Shifts

**Transition to Patient Centric, Value-Based Care**

- $765B of waste in the US
- Increased prevalence of value-based models such as ACOs
- Lack of coordination / interoperability amongst silos of care

**Transition to Molecular Profile and Real-time Biometric-Driven Medicine**

- $552B precision medicine market
- Evolution toward comprehensive genomic and proteomic analysis
- Increased connectivity of biometric devices
- Overwhelming amounts of data and facts to arrive at a patient decision
Big Data Oncology Platform: Key Capabilities and Attributes

- ✓ Low cost of ownership
- ✓ Open APIs
- ✓ Data rights
- ✓ High availability and Performance
- ✓ Phenotype data, Bio-metric data, genomic and proteomic data
- ✓ Data integration between payors, providers and Pharma
- ✓ Always-on collaboration and network connectivity
- ✓ Powerful analytics at population, patient and provider
Learning Health System Enables...

1. Better diagnosis, better treatment selection....
2. Better care coordination...large volumes of bio-metric data
3. Better and faster data collection....

Better outcomes
Lower cost of care
Faster identification of high value treatments, payment for value with real time connectivity with payor