Building Data and Knowledge Management Systems Across the Cancer Control System

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Alliance for Clinical Trials in Oncology
Disclosures:
one relevant to today’s discussion

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  – AbbVie
  – Agenus
  – Astellas
  – AstraZeneca
  – Baxalta
  – Bayer HealthCare
  – Breast Cancer Research Foundation
  – Bristol-Myers Squib
  – Celgene
  – Complion
  – Czarnowski
  – Derse, Inc.
  – Eisai
  – Exelixis
  – Genentech
  – GHI
  – Gilead Sciences
  – GSK Total
  – Incyte Corporation
  – Janssen
  – Jazz Pharma
  – Leap Therapeutics
  – Leidos
  – Lexicon Pharma
  – Lilly
  – Maltrex
  – Merck
  – Millennium
  – Novartis
  – Pfizer
  – Pharmacyclics
  – Robert Wood Johnson Foundation
  – Roche/Genentech
  – Sagerock Advisors
  – Sanofi
  – STO
  – Syntalogic
  – Taiho Oncology
  – Takeda
  – Tesaro
  – Teva
Data-Driven Improvements in Clinical Care

Clinical Research:
- Randomized Clinical Trials
- Pragmatic Trials
- Comparative Effectiveness Research
- Observational Research: Longitudinal Cohorts, Registries

Quality Improvement:
- Quality Metrics
- Clinical Pathways/Decision Support

Economic Factors:
- Health Care Resource Utilization

Current state of data accumulation:
Fragmented, Siloed, Expensive, Inefficient
Current State

Mrs. Smith, a 75 year old generally healthy but obese woman, presented to an emergency room with gastrointestinal bleeding.

Upper endoscopy:
- tumor at the junction of the esophagus and the stomach

Biopsy:
- gastrointestinal stromal tumor
Current State

**Current State**

*CT Images not available

data entry required:
demographics/insurance/contacts
complete medical history

*CT Images not available
Current State

- Sent home, but worried because of no definite treatment plan
  - Next day: Emergency Room visit
    - She lives alone, her daughter misses several days of work to coordinate her care
    - Non-reimbursed medical expenses are increasing
Current State

- 2 days later, her CT scan arrives

Medical Oncology referral
Current State

- Imatinib recommended; genotyping ordered

**Result:**

[Diagram showing protein structure with D842V (TK2 domain) highlighted]

**Conclusion:** Imatinib is not effective
Current State

• Declines clinical trial participation

• Subtotal gastrectomy performed

• Lengthy post operative recovery

• No adjuvant therapy, higher risk for disease recurrence
# Current State

## Outcome of 1000 Patients With Gastrointestinal Stromal Tumor (GIST) Treated by Surgery in the Pre and Post-imatinib Eras

Michael J. Cavnar, MD,* Kenneth Seier, MsC,† Christina Curtin, BS,* Vinod P. Balachandran, MD,* Daniel G. Coit, MD,* Sam S. Yoon, MD,* Aimee M. Crago, MD, PhD,* Vivian E. Strong, MD,* William D. Tap, MD,‡∥ Mihat Gönen, PhD,† Cristina R. Antonescu, MD,§ Murray F. Brennan, MD,* Sam Singer, MD,* and Ronald P. DeMatteo, MD*

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<table>
<thead>
<tr>
<th>Mutation Type</th>
<th>Count</th>
<th>Percentage</th>
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<tbody>
<tr>
<td>KIT exon 9</td>
<td>44</td>
<td>7.6</td>
</tr>
<tr>
<td>KIT exon 11 deletion</td>
<td>216</td>
<td>37.1</td>
</tr>
<tr>
<td>KIT exon 11 other</td>
<td>117</td>
<td>20.1</td>
</tr>
<tr>
<td>KIT exon 13</td>
<td>9</td>
<td>1.5</td>
</tr>
<tr>
<td>KIT exon 17</td>
<td>4</td>
<td>0.7</td>
</tr>
<tr>
<td>KIT multiple exons</td>
<td>48</td>
<td>8.2</td>
</tr>
<tr>
<td>PDGFRA D842V/I</td>
<td>23</td>
<td>4.0</td>
</tr>
<tr>
<td>PDGFRA other</td>
<td>27</td>
<td>4.6</td>
</tr>
<tr>
<td>NF1</td>
<td>5</td>
<td>0.9</td>
</tr>
<tr>
<td>SDH</td>
<td>3</td>
<td>0.5</td>
</tr>
<tr>
<td>Wild-type</td>
<td>86</td>
<td>14.8</td>
</tr>
<tr>
<td>Unknown</td>
<td>418</td>
<td>N/A</td>
</tr>
</tbody>
</table>
Our Future

• Mrs. Smith presents with a high risk gastrointestinal stromal tumor, complicated by gastrointestinal bleeding

• Well before her visit, her full EHR, including all images, is available to you formatted in a manner identical with the one that your team uses
Our Future

Nonmetastatic gastrointestinal stromal tumor, high risk

Outcomes for 12,345 patients with GIST were captured by CancerLinQ.

Similar patients
- 914 patients, age-matched >70

Outcomes
- Overall survival rate and common

Overall survival rates
- 1 yr: 95%
- 2 yr: 90%
- 5 yr: 77%

include only: add/remove surgery
- (11) Imatinib mesylate
  - (70)

combine with: select treatments
- Imatinib mesylate
  - (70)

*tumor mutational testing may change recommendations, likelihood of this is 15% with gastric location of primary tumor; CLINICAL TRIALS MAY BE AVAILABLE

*recommend pre-operative functional assessment due to age, BMI
Our Future

• **PLAN:**
  – Genotyping, initiate pre-operative imatinib
  – Home-based fitness program in preparation for surgery in ~6 months
Our Future

Back home, Mrs. Smith is concerned that her bowel movements are a bit dark, and calls her granddaughter, who reports this to the web-based patient support site coordinated by your clinic.
Our Future

• Tumor genomic characterization results show you that she is unlikely to respond to imatinib

[References]
Journal of Clinical Oncology 36, no. 15_suppl (May 20, 2018) 11533-11533.

A retrospective natural history study of patients (pts) with PDGFRα D842V mutant advanced gastrointestinal stromal tumor (GIST) previously treated with a tyrosine kinase inhibitor (TKI).

Margaret von Mehren, Michael C. Heinrich, Hongliang Shi, Patrick McNamara, Khalid Kevin Mamlouk, Anthony Boral, ...

• Treatment change: surgery or treatment on a clinical trial
Our Future

**NAVIGATOR Phase 1 study design**

**Part 1 dose escalation**

- Advanced GIST (N = 46)
  - RP2D
  - avapritinib PO QD

- PDGFRα D842V (n = 33)
  - Registration enabling – fully enrolled

- ≥3L (n = 116)
  - ≥4L registration enabling – fully enrolled

- 2L
  - Ongoing (n ~50)

**Study Design**

- GIST patients with advanced or metastatic GIST with a D842V mutation
  - Randomization 2:1
  - Crenolanib: 100mg 3x/day, continuously
  - Placebo: 3x/day, continuously
Our Future

- Successful surgery, minimally invasive gastric resection
- Smooth post-operative recovery
Our Future

Five years later:
• International cohort: 90% of GIST patients,
  – 390 cases with a pD842V mutation

• Prospectively collected overall survival data from clinical trials and EHR-based longitudinal data
Our Future

- Clinical care is **efficient**
- Unnecessary **costs are reduced**
- **Home-based** evaluations and interventions are facilitated
- Patients and families are **engaged and informed**
- **Errors** caused by poor communication are reduced
- Research is **facilitated**
- **Learning is integrated** into every-day practice

**WHY IS THIS SO DIFFICULT TODAY?**
Definition: Learning Health System

"An integrated health system which harnesses the power of data and analytics to learn from every patient and feed the knowledge of what works best back to clinicians, health professionals, patients and other stakeholders to create cycles of continuous improvement."

Friedman CP et al, 2010; Sci Trans Med 2:57
RECOMMENDATION A: A U.S. National Cancer Control Plan should principally ensure resource integration and operational coordination across the various components of the cancer control system and should actively do the following:

- Improve, where feasible, effective, and affordable, the availability of preventive, screening, diagnostic, and therapeutic interventions. Encourage timely palliative care, hospice care, survivorship services, and related social services according to the preferences and values of patients and their families.
- Leverage the advances in and apply “multi-omic” diagnostics to improve therapies and better understand their scientific, clinical, and economic implications.

Integrate the use of social, behavioral, and other information made possible by the convergence of communication, social media, cognitive, financial, and sensor technologies as well as electronic health records, cancer registries, and insurance claims to establish large-scale interoperable data sources.

- Apply the tools of complex systems analyses for assessing the “value” of cancer control interventions, establishing robust policy and incentive packages to guide the development and commercialization of products and services, developing new financing and payment mechanisms that alleviate overall cost burden, and aiding individual patients and their families in making informed decisions about cancer care.
- Minimize the waste and harm stemming from disparate clinical practices, interventions lacking evidence of effectiveness, and conflicting clinical practice guidelines.
- Track and monitor financial links, incentives, and disincentives throughout the processes and systems of cancer control and rigorously require conflict-of-interest disclosures across cancer care, research, and patient advocacy activities.
- Expand and support reproducibility strategies for developing reliable evidence in cancer control from biomedical, clinical, public health, and social science research.
- Discourage direct-to-consumer marketing and advertising of clinical products and services from companies, medical centers, intermediary firms, and other organizations by terminating the tax deductibility of these business expenses. Furthermore, tighten and enforce rules to particularly curb promotional tactics and strategies that are likely to mislead patients about the benefits of products and care services not based on strong evidence.
- Launch and expand public engagement, literacy, and outreach activities, starting with K–12 curriculums and through technology platforms, to broaden the understanding of cancer prevention as an integral component of a healthy life course.
TOOLS AND ANALYTICS
DATA ACCESS
HIGH QUALITY COMPUTABLE DATA
### Structured Data Elements From Current EHRs

<table>
<thead>
<tr>
<th>Generally Available</th>
<th>Generally Not Available</th>
</tr>
</thead>
<tbody>
<tr>
<td>- Diagnosis codes</td>
<td>- Surgery</td>
</tr>
<tr>
<td>- Encounter codes</td>
<td>- Radiation Therapy</td>
</tr>
<tr>
<td>- Infused medications</td>
<td>- Imaging results</td>
</tr>
<tr>
<td></td>
<td>- Disease status (progressing, stable, NED)</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Sometimes Available</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>- Staging (group and individual elements)</td>
<td>- ER/PR/Her2 tests</td>
</tr>
<tr>
<td>- Oral medications</td>
<td>- ECOG performance scores</td>
</tr>
<tr>
<td></td>
<td>- Hospice referral</td>
</tr>
</tbody>
</table>

- Laboratory tests
- Smoking/Pain assessments
- Physical exam values
- Histology
- Genetic tests
- Treatment intent
**Tobacco Use Assessment**

<table>
<thead>
<tr>
<th>Value</th>
<th>Distinct Patients</th>
</tr>
</thead>
<tbody>
<tr>
<td>Non-smoker</td>
<td>560,281</td>
</tr>
<tr>
<td>Never smoked tobacco</td>
<td>462,842</td>
</tr>
<tr>
<td>Ex-smoker</td>
<td>373,431</td>
</tr>
<tr>
<td>Current smoker</td>
<td>121,186</td>
</tr>
<tr>
<td>Unknown tobacco consumption</td>
<td>83,550</td>
</tr>
<tr>
<td>Smokes tobacco daily</td>
<td>81,250</td>
</tr>
<tr>
<td>Occasional tobacco smoker</td>
<td>22,607</td>
</tr>
<tr>
<td>Heavy smoker</td>
<td>5,898</td>
</tr>
<tr>
<td>Light tobacco smoker</td>
<td>3,478</td>
</tr>
<tr>
<td>Tobacco user</td>
<td>576</td>
</tr>
<tr>
<td>Current tobacco non-user</td>
<td>212</td>
</tr>
<tr>
<td>Chews tobacco</td>
<td>160</td>
</tr>
<tr>
<td>Passive smoker</td>
<td>140</td>
</tr>
<tr>
<td>Smokeless tobacco</td>
<td>96</td>
</tr>
<tr>
<td>Pipe smoker</td>
<td>23</td>
</tr>
</tbody>
</table>

* >15.5 million entries

**Subset of 51 different representations**

**EMRs:**
- Allscripts
- Epic
- Aria
- Mosaiq
- Centricity
- OncoEMR
- CureMD
- NextGen
We need better data!

Retrospective data curation using machine learning and national language processing is INSUFFICIENT and NOT SCALABLE

1.6 million patient records received
Collaboration isn't a 21st Century skill. It's a timeless skill.

Collaboration was critical in the past and it will be critical in the future. Humans had to collaborate in the age of hunter-gathering and we’ll need it in the age of artificial intelligence.
Purpose: To develop and maintain standard computable data formats, known as Minimal Common Oncology Data Elements (mCODE), to achieve data interoperability and enable progress in clinical care quality initiatives, clinical research, and healthcare policy development

mcodeinitiative.org
mCODE™
Will facilitate research

Integrating Clinical trials And Real world Endpoints data
mCODE™
Will facilitate data sharing
A wide range of organizations will develop mCODE-enabled tools for data capture, analysis, and clinical application

- Clinical pathways
- Clinical decision support
- Care coordination
- Clinical trials data management
- Clinical registries
- Outcomes research models
- Clinical practice quality initiatives
- Development and implementation of machine learning approaches
will facilitate patient engagement in healthcare

- Consent for research data use
- Patient reported outcomes
- Medical records home
- Patient education

- Care coordination
- Wellness programs
- Chronic disease management
- Rare disease care & research
Who benefits?

- Academia
- Regulatory Agencies
- Clinicians
- CMS
- Payers
- Patients
- Government
- Health Systems
- Private Industry
mCODE™

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