Advancing Innovation and Convergence in Cancer Research

Jerry S.H. Lee, Ph.D.
Health Sciences Director
Deputy Director, Center for Strategic Scientific Initiatives (CSSI)
Office of the Director, National Cancer Institute (NCI)
National Institutes of Health (NIH)

Northern California Blood Cancer Conference, Hyatt Regency- San Francisco
Feb 4, 2017
• **WHY** am I here?

• **WHO** I am & **WHAT** is CSSI?

• **WHY** data quality & sharing are **IMPORTANT**

• **2016** at a glance

• **2017** moving the needle
Systems Biology and the Impact on Understanding Cancer

Systems Fiveology
Fredricka Hunter
Sanford Joanes
Kim Alexander Powell
Lauren Wijkeran
Patient Mentor: Peg Ford
Scientific Mentor: Dr. Jerry Lee

AACR American Association for Cancer Research

04/09/2013
CANCER COMPLEXITY

Work Group 4: Mary Kay Dauria, Leila Evangelista, Jeri Francoeur, Michael Jones, Yoshiyuki Majima, Jeannine Walston
Mentor: Cynthia Ryan, Ph.D.
Scientific Mentor: Jerry Lee, Ph.D.

American Association for Cancer Research
Mission

• Make a **decade’s** worth of progress in **cancer prevention, diagnosis, treatment, and care** – ultimately to end cancer as we know it.
2001 – Nature: The human genome

2010 – A Thousand Genomes

2015 – The Precision Medicine Initiative

1 million healthy genomes
1,685,210
new cases of cancer in the U.S.

595,690
projected deaths due to cancer in the U.S.
2016

15,533,220 cancer survivors in the U.S.
“...asked what tied the various aspects of the Moonshot together, he [Daniel Hayes] answered with a single word: data. Most of the specific research recommendations envision the aggregation of huge amounts of data and the extraction of important discoveries from those collection points...”
Automated dermatologist’ detects skin cancer with expert accuracy

By Susan Scotti, CNN
Updated 6:37 PM ET, Thu January 26, 2017

Dermatologist-level classification of skin cancer with deep neural networks

Andre Esteva¹, Brett Kuprel¹, Roberto A. Novoa²,³, Justin Ko², Susan M. Swetter²,⁴, Helen M. Blau⁵ & Sebastian Thrun⁶

Skin cancer, the most common human malignancy¹–³, is primarily diagnosed visually, beginning with an initial clinical screening and followed potentially by dermoscopic analysis, a biopsy and histopathological examination. Automated classification of skin lesions using images is a challenging task owing to the fine-grained variability in the appearance of skin lesions. Deep convolutional neural networks (CNNs)⁴–⁵ show potential for general and highly variable tasks across many fine-grained object categories⁶–¹¹. Here we demonstrate classification of skin lesions using a single CNN, trained end-to-end from images directly, using only pixels and disease labels as inputs. We train a CNN using a dataset of 129,450 clinical images—two orders of magnitude larger than previous datasets¹²—consisting of 2,032 different diseases. We test its performance against 21 board-certified dermatologists on biopsy-proven clinical images with two critical binary classification images (for example, smartphone images) exhibit variability in factors such as zoom, angle and lighting, making classification substantially more challenging¹²–¹⁴. We overcome this challenge by using a data-driven approach—1.41 million pre-training and training images make classification robust to photographic variability. Many previous techniques require extensive preprocessing, lesion segmentation and extraction of domain-specific visual features before classification. By contrast, our system requires no hand-crafted features; it is trained end-to-end directly from image labels and raw pixels, with a single network for both photographic and dermoscopic images. The existing body of work uses small datasets of typically less than a thousand images of skin lesions¹⁵,¹⁶,¹⁷,¹⁸ which, as a result, do not generalize well to new images. We demonstrate generalizable classification with a new dermatologist-labelled dataset of 129,450 clinical images, including 3,374 dermoscopy images.
“...an advantage of machine learning is that it can be used even in cases where it is infeasible or difficult to write down explicit rules to solve a problem...”
Modified from Abernethy et al. JCO 2010
“...to apply machine learning, a practitioner starts with a **historical data set**, which the practitioner divides into a **training set** and a **test set**...”
Opportunity exists to generate publicly available longitudinal data to drive understanding of genetic mutations and find Precision Medicine cures

*Datasets have potential to include longitudinal data in the future
**Public/private information not available
***Serves as a portal also, has potential to include longitudinal data in the future

1. FoundationCore’s pediatric cancer data has been made public
U.S. National Cancer Program: Stakeholders

~$18 B per year

Private Industry $9.2 B

NCI $5 B

Fed/State $3.4 B

NPO/Foundations, $0.6 B

Acting Director
Douglas R. Lowy, MD
Mission

“…to create and uniquely implement exploratory programs focused on the development and integration of advanced technologies, trans-disciplinary approaches, infrastructures, and standards, to accelerate the creation and broad deployment of data, knowledge, and tools to empower the entire cancer research continuum in better understanding and leveraging knowledge of the cancer biology space for patient benefit…”
2006-2015: Building a historical data set

A Decade of Illuminating the Underlying Causes of Primary Untreated Tumors

(12,000+ patient tumors and increasing)
2002

**THE LANCET**

**Mechanisms of disease**

**Use of proteomic patterns in serum to identify ovarian cancer**

**Summary**

Background New strategies for the detection of early-stage ovarian cancer are needed. Initial biochemical, molecular, and functional studies have indicated that ovarian cancer may develop in a distinctive proteomic pattern, which is identifiable in serum. Here we report the results of a blinded, prospective, and randomised study to test the feasibility of detecting ovarian cancer early.

Methods In this study, serum samples (n = 59) from 28 patients with ovarian cancer and 31 from healthy women were analyzed by mass spectrometry to identify proteins that are differentially expressed in ovarian cancer. We developed a proteomic pattern of ovarian cancer that is based on the expression of 15 proteins.

Findings This method is able to detect ovarian cancer in the serum of patients with early-stage disease. The expression patterns vary significantly in different stages of disease, and 14 of the 15 proteins tested are detectable in sera from all stages. By using cluster analysis, we were able to identify a group of 15 serum markers that can distinguish between ovarian cancer and healthy women with 96% accuracy.

Conclusion This method is feasible for the detection of ovarian cancer. Further studies are required to determine the clinical utility of this method in routine practice.

**Lancet** 2002; 359: 572-577

2004

**nature**

**Running before we can walk?**

Two years ago, a new proteomic test was marketed as the future of cancer diagnostics. But since then, doubts about its effectiveness have begun to grow. "We're the ones who wrote the paper," says John Lucas, who led the study. "But we're not the ones who wrote the conclusion." The test uses serum samples to detect ovarian cancer, but its reliability has been questioned.

**Nature** 2004; 429: 496-497

2004

**The New York Times**

**New Cancer Test Stirs Hope and Concern**

**By ANDREW POGGIE**

Alzheimers disease was diagnosed in 2004 as one of the leading causes of death in the United States. Alzheimer's disease is characterized by the presence of plaques and tangles in the brain, which is a hallmark of the disease. The diagnosis of Alzheimer's disease can be made with certainty only at postmortem examination. However, there is currently no definitive test for the disease during life.

**The New York Times** January 3, 2004

**"One of the most important achievements of medical science..."**

The test used for the detection of Alzheimer's disease is the magnetic resonance imaging (MRI) scan. MRI scans can detect the presence of plaques and tangles in the brain, which is a characteristic feature of Alzheimer's disease. The test can also help to diagnose other conditions that can cause symptoms similar to Alzheimer's disease, such as vascular dementia and Lewy body dementia.

**The New York Times** January 3, 2004

**"One of the most important achievements of medical science..."**
“What is Water?”: Measurements → Insights

Measurements

- Color (clear, yellow, brown)
- Taste (none, metallic, awful)
- Phase (liquid, gas, solid)
- Phase change (boil, melt, freeze)

Quantitative "Data"

<table>
<thead>
<tr>
<th></th>
<th>Saturated Steam</th>
<th>Uniquemol Steam</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pressure (kPa)</td>
<td>Units</td>
<td>Specific volume</td>
</tr>
<tr>
<td>1</td>
<td>1000</td>
<td>2.13</td>
</tr>
<tr>
<td>2</td>
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</tr>
<tr>
<td>10</td>
<td>10,000</td>
<td>0.00</td>
</tr>
</tbody>
</table>

Lots of Quantitative "Data"

But also LOTS of disagreements...

Boiling point = 92°C
Boiling point = 100°C
“What is Water?”: Standards and Sharing of Data → New Insights and Understanding

- Define samples and protocols
- Share collected data

Boiling point = 92°C

Boiling point = 100°C

2400m

New Parameter

“Pressure”

New Understanding

- Phase boundaries
- V/L equilibrium
- Triple Point

(Phase Diagram)

LOTS of Quantitative and Reproducible Data

(Steam Table)
Many “Thermometers” (Genomics and Proteomics)
“...We found that specimens obtained late in the week are more likely to be ER/PR negative than specimens obtained on other weekdays...”

Table 1. Frequency of Specimen Removal by Day of the Week

<table>
<thead>
<tr>
<th>Day</th>
<th>Cases</th>
<th>ER-Negative</th>
<th>PR-Negative</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sunday</td>
<td>16</td>
<td>3</td>
<td>6</td>
</tr>
<tr>
<td>Monday</td>
<td>1252</td>
<td>230</td>
<td>325</td>
</tr>
<tr>
<td>Tuesday</td>
<td>1176</td>
<td>248</td>
<td>332</td>
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<tr>
<td>Wednesday</td>
<td>784</td>
<td>170</td>
<td>212</td>
</tr>
<tr>
<td>Thursday</td>
<td>904</td>
<td>191</td>
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<tr>
<td>Friday</td>
<td>919</td>
<td>216</td>
<td>276</td>
</tr>
<tr>
<td>Saturday</td>
<td>26</td>
<td>7</td>
<td>8</td>
</tr>
<tr>
<td>System</td>
<td>5077</td>
<td>1065</td>
<td>1418</td>
</tr>
</tbody>
</table>

Abbreviations: ER, estrogen receptor; PR, progesterone receptor.
<table>
<thead>
<tr>
<th>Tumor Type</th>
<th>Count</th>
</tr>
</thead>
<tbody>
<tr>
<td>Glioblastoma</td>
<td>563</td>
</tr>
<tr>
<td>Brain lower grade glioma</td>
<td>180</td>
</tr>
<tr>
<td>Head &amp; neck</td>
<td>306</td>
</tr>
<tr>
<td>Thyroid carc</td>
<td>401</td>
</tr>
<tr>
<td>Lung adeno</td>
<td>356</td>
</tr>
<tr>
<td>Lung squamous</td>
<td>343</td>
</tr>
<tr>
<td>Breast carc</td>
<td>866</td>
</tr>
<tr>
<td>Stomach adeno</td>
<td>237</td>
</tr>
<tr>
<td>Liver hep. carc</td>
<td>97</td>
</tr>
<tr>
<td>Kidney pap. cell carc</td>
<td>103</td>
</tr>
<tr>
<td>Kidney clear cell carc</td>
<td>493</td>
</tr>
<tr>
<td>Ovarian serous</td>
<td>559</td>
</tr>
<tr>
<td>Uterine corpus end. carc</td>
<td>492</td>
</tr>
<tr>
<td>Cervical carc</td>
<td>102</td>
</tr>
<tr>
<td>Bladder carc</td>
<td>135</td>
</tr>
<tr>
<td>Prostate adeno</td>
<td>171</td>
</tr>
<tr>
<td>Colon/rectum adeno</td>
<td>575</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>5,979</strong></td>
</tr>
</tbody>
</table>
Central Dogma of Biology

DNA → RNA → Protein

The Cancer Genome Atlas
Re-writing Central Dogma “Rule”

On average across 375 tumor samples, **ONLY 33%** of DNA/RNA predicted cancer protein abundance

"…there is great potential for new insights to come from the combined analysis of cancer proteomic and genomic data, as proteomic data can now reproducibly provide information about protein levels and activities that are difficult or impossible to infer from genomic data alone…”

Douglas R. Lowy, MD
Acting Director of the National Cancer Institute, National Institutes of Health

5/25/2016
Mission

• Make a decade’s worth of progress in cancer prevention, diagnosis, treatment, and care – ultimately to end cancer as we know it.
<table>
<thead>
<tr>
<th>STRATEGIC GOALS</th>
<th>IMPLEMENTATION PATH</th>
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</thead>
<tbody>
<tr>
<td>Catalyze New Scientific Breakthroughs</td>
<td>FEDERAL PUBLIC-PRIVATE COLLABORATION PRIVATE/ NON-PROFIT</td>
</tr>
<tr>
<td>Unleash the Power of Data</td>
<td></td>
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<tr>
<td>Accelerate Bringing New Therapies to Patients</td>
<td></td>
</tr>
<tr>
<td>Strengthen Prevention and Diagnosis</td>
<td></td>
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<tr>
<td>Improve Patient Access and Care</td>
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</tr>
</tbody>
</table>

2/1/2016  10/17/2016
Cancer Moonshot Data & Technology Team

Co-Chairs: Dimitri Kusnezov (DOE), DJ Patil (OSTP), and Jerry Lee (OVP)

Members:

- John Scott (DoD)
- Craig Shriver (DoD)
- Cheryll Thomas (CDC)
- Frances Babcock (CDC)
- Teeb Al-Samarrai (DOE)
- Sean Khozin (FDA)
- Alexandra Pelletier (PIF)
- Maya Mechenbier (OMB)
- Henry Rodriguez (NCI)
- Karen Cone (NSF)
- Michael Kelley (VA)
- Louis Fiore (VA)
- Warren Kibbe (NCI)
- Betsy Hsu (NCI)
- Niall Brennan (CMS)
- Thomas Beach (USPTO)
- Claudia Williams (OSTP)
- Vikrum Aiyer (USPTO)
- Tom Kalil (OSTP)
- Kathy Hudson (NIH)
- Dina Paltoo (NIH)
- Al Bonnema (DoD)
- Michael Balint (PIF)
- Kara DeFrias (OVP)
- Greg Pappas (FDA)
- Erin Szulman (OSTP)
- Paula Jacobs (NCI)
Translational from basic science to human studies

- Defining mechanisms, targets, and lead molecules
- Controlled studies leading to effective care
- New methods of diagnosis, treatment, and prevention

TCGA
MPACT
LungMAP
ALCHEMIST

2004

Translational of new data into the clinic and health decision making

- Delivery of recommended and timely care to the right patient
- True Benefit to society

T3
T4

TRANSLATION TO PRACTICE
TRANSLATION TO COMMUNITY

Phase 4 clinical trials and clinical outcomes research
Population-level outcomes research
Without a National Learning Healthcare System for Cancer

Primary Care (Months-Years) → Cancer Diagnosis and Treatment

Patient → Cancer Center

Unable to Share Primary Care Data

Lost Opportunity to Learn from Pre-Cancer Clinical Data

Cancer Survivor (Months-Years)

Primary Care

Unable to Share Cancer Care Data

Cancer Relapses

Assumes returning to the same cancer care facility

Lost Opportunity to Learn from Post-Cancer Treatment Clinical Data
Vision:

Enable the creation of a *Learning Healthcare System for Cancer*, where as a nation we learn from the *contributed knowledge* and experience of *every cancer patient*. As part of the Cancer Moonshot, we want to *unleash the power of data* to enhance, improve, and inform the journey of every cancer patient from the *point of diagnosis through survivorship*. 
**Fig 1.** Cycle of evidence in rapid-learning health care. In a patient-centered system of rapid-learning health care, patient-level data are aggregated to achieve population-based change, and results are applied to care of individual patients to achieve meaningful patient-level practice change.
Priority Area A: Enabling a seamless data environment  

Priority Area B: Unlocking science through open computational and storage platforms

Priority Area C: Workforce development using open and connected data
NCI Blue Ribbon Panel Report Recommendations

A. Establish a network for direct patient involvement
B. Create a clinical trials network devoted exclusively to immunotherapy
C. Develop ways to overcome cancer’s resistance to therapy
D. Build a national cancer data ecosystem
E. Intensify research on the major drivers of childhood cancers
F. Minimize cancer treatment’s debilitating side effects
G. Expand use of proven cancer prevention and early detection strategies
H. Mine past patient data to predict future patient outcomes
I. Develop a 3-D cancer atlas
J. Develop new cancer technologies

http://www.cancer.gov/brp
2.6 PB of legacy data and 1.5 PB of harmonized data.
Making Data FAIR

Findable
Accessible
Interoperable
Reusable
My Local “Data” & Reuse

“Data” Uploads

Reuse A

“Data” Uploads

Reuse B
At the June 29th Cancer Moonshot Summit, Foundation Medicine announced the release of **18,000** genomic profiles to the NCI GDC.
Multiple Myeloma Research Foundation to Contribute to NCI's Genomic Data Commons

Sep 29, 2016 | a GenomeWeb staff reporter

- MMRF is the first non-profit organization to upload information to the GDC
- Among its contributions will be data from relating Clinical Outcomes in MM to Personal Assessment of Genetic Profile (CoMMpass) study which began in 2011 and has thus far enrolled over 1,150 patients
- Over the next eight years, patients in CoMMpass will get a repeat biopsy and a new genomic analysis at each six-month checkup and/or at disease progression
- Tumor samples are being collected and analyzed when possible at the time of any relapse. New data will be deposited every six months at a minimum
“…while many of the important lessons learned from this first year of the project…Sawyers said that the data also speaks for itself in terms of the project's success in tackling difficult harmonization challenges…

…All the subjects in the GENIE collection had to have level 1A clinical data, Sawyers explained, and the group had to make sure that they could harmonize this information across sites. For example, "you can imagine a name of a rare condition might be very different in Amsterdam versus Toronto or Nashville," Sawyers said…”
### GDC Content

#### Current
- TCGA: 11,353 cases
- TARGET: 3,178 cases

#### Coming soon
- Foundation Medicine: 18,000 cases
- Cancer studies in dbGAP: ~4,000 cases

#### Planned (1-3 years)
- NCI-MATCH: ~3,000 cases
- Clinical Trial Sequencing Program: ~3,000 cases
- Cancer Driver Discovery Program: ~5,000 cases
- Human Cancer Model Initiative: ~1,000 cases
- APOLLO – VA-DoD: ~8,000 cases

Total cases: ~56,000 cases
Col. Craig Shriver, MD

Jennifer Lee, MD

Henry Rodriguez, PhD, MBA

https://medium.com/cancer-moonshot/
Patients with new or recurrent cancer diagnosis

Veterans

Active Duty & DoD Beneficiaries

Civilians

Co-enroll MVP

Consents to VA/DoD/NCI APOLLO research program

The American Genome Center

Murtha Cancer Center

Consents to VA/DoD/NCI APOLLO research program

Residual tissue for CLIA-approved targeted sequencing (CATS)

VA Hospitals

VA Hospitals

VA ORD and NCI-sponsored Clinical Trials

Clinical Phenotype & outcomes

VA Hospitals

Adaptive Learning Healthcare System

VA Hospitals

National Cancer Institute

NIH

DM

NIH

VA Hospitals

Murtha Cancer Center

データの集約、分析、および共有により、活動対象、受益者、退伍兵、および市民の結果を急速に改善します。

APOLLO – Applied Proteogenomics Organizational Learning and Outcomes consortium
Without a National Learning Healthcare System for Cancer

Primary Care (Months-Years) → Patient → Cancer Center → Cancer Diagnosis and Treatment → Cancer Survivor (Months-Years) → Primary Care → Cancer Relapses

Unable to Share Primary Care Data

Lost Opportunity to Learn from Pre-Cancer Clinical Data

Lost Opportunity to Learn from Post-Cancer Treatment Clinical Data

Assumes returning to the same cancer care facility
MCC Military Clinical Trials Network

Clinical Trials
Increased Access

Referral Center
High cost/low volume

Genetics Counseling
Telehealth technologies

Training & Education
Distributed learning/fellowships

Patient Outreach
Education and information

Standardized Clinical Practice Guidelines
Evidenced-based clinical practice & research

MCC Membership

MHS

Naval Medical Center Portsmouth, VA

Naval Medical Center San Diego, CA

Womack Army Medical Center Ft Bragg, NC

Keesler Air Force Medical Center Biloxi, MS

Lackland Air Force Medical Center San Antonio, TX
Patient and Providers

Initiate system for specific learning or research activities

Ongoing clinical care

Usual care continues

Research activities

Ongoing collection of data [genomics, proteomics, medical imaging]

Courtesy of Lou Fiore
Applied Proteogenomics Organizational Learning and Outcomes

APOLLO Leadership Meeting
August 29, 2016
Data Contributors and Consumers
Researchers  Institutions  Clinicians  Patients

NCI Thesaurus  caDSR  NLM UMLS  RxNorm  LOINC  SNOMED
“…proteogenomics, which is -- as I used a metaphor -- it’s like the genes are the full roster of a basketball team....but the winning strategy comes from finding out who their starting lineup is. The proteins are the starters you're going to play against -- the five you are going to have to defend against

I’m pleased to say, Mr. Prime Minister, that we've signed three memorandums of understanding between our two nations ...we're going to be able to share patient histories, proteogenomics and clinical phenotypes data -- data on various proteins and genetic characteristics of almost 60,000 patients in Australia and the United States with full privacy protections...

And I predict that you're going to see this repeated around the world.”

- Vice President Biden, Australia
Joe Biden announces major new steps in his fight for better cancer research

The first step is the announcement of 10 new commitments with nine nations to support better international cancer research and care. The U.S. will work with institutions in Canada, China, Germany, Switzerland, Taiwan, Japan and South Korea in the field of proteogenomics, and with Serbia, Sweden and Japan to open a discussion about better prevention, screenings, treatment and research collaborations. The U.S. Department of Energy will also work with Norway to share 1.7 million cervical screening results over the course of 25 years to seek out patterns in diagnoses and treatments.

Biden also announced the creation of regional hubs — collaborative centers that can help decrease disparities in cancer research around the world. These hubs will be funded by the National Cancer Institute, working with Japan, South Korea, New Zealand, the United Kingdom and a dozen other nations.

International Proteogenomic Moonshot Programs

7 MOUs
7 countries
14 institutions
Modified from Abernethy et al. JCO 2010
What About Blood?
Eight Milestones Of 2016 In The War On Cancer

Only 32 novel drugs were approved by the U.S. Food & Drug Administration in 2016—way down from the 45 approved in 2015—and just six of the new entries are for treating or diagnosing cancer. Still, 2016 was far from a washout for oncology research. Here were some of the high points of the year in the war on cancer:

January 12: V.P. Biden is tapped to lead the new Cancer Moonshot. During the State of the Union address, President Barack Obama launched the Cancer Moonshot and appointed Vice President Joe Biden to lead the initiative. The goal is not just to speed new therapies to market, but also to improve access to treatment and come up with methods for detecting the disease early, when it’s easier to treat and cure. Biden spent much of the year tapping academics, drug company executives, patients and physicians for advice, as well as establishing five strategic goals for the Moonshot.

In October, the veep announced a new project called the Blood Profiling Atlas, which will try to accelerate the development of “liquid biopsies,” tests designed to detect early-stage cancer by tracking tiny bits of tumor DNA cast off into the bloodstream. Much to the surprise of some executives, he assembled an impressive list of organizations that might normally balk at the idea of working together to help build the atlas, including Novartis, Pfizer, Thermo Fisher and Foundation Medicine.

April 13: Napster billionaire Sean Parker launches a cancer institute. The glitzy star-studded gala that ushered in Sean Parker’s new cancer research institute may have drawn some ire, but the money the Napster founder and former Facebook president is devoting to the effort is nothing to sneeze at. The Parker Institute for Cancer Immunotherapy is backed...
Finding the Right “Needle” at the Right “Time” of Disease
Biden announces USC participation in new Cancer Moonshot project

The project aims to accelerate the development of reliable blood tests for biologically based precision treatment and disease monitoring.

Seven Bridges Joins Cancer Moonshot Initiative with Cloud Platform to Speed Blood Profiling Research


U-M researchers will support new ‘liquid biopsy’ Cancer Moonshot initiative

Government, academia, pharma partnership will create open dataset to stimulate translational research.

Lilly Partnering on Cancer Research

Posted: Oct 17, 2016 5:00 PM EDT
Updated: Oct 18, 2016 8:53 AM EDT

White House To Announce Big Push For Cancer Blood Tests

Forbes

Guardant Health makes commitment to share expertise and data to advance Blood Profiling Atlas, part of White House Cancer Moonshot

College Of American Pathologists To Participate In The Cancer "Moonshot" Effort

Industry News: Thermo Fisher Scientific Joins the Cancer Moonshot Initiative to Help Advance Precision Medicine
10/18/16: Blood Profiling Atlas Face 2 Face
Blood Profiling Atlas Members

- Open Commons Consortium (OCC) in collaboration with the University of Chicago commits to organizing and operating an open Blood Profiling Atlas Commons. The Commons will be based upon the same open source software stack used by the NCI Genomic Data Commons so that the genomic, image and clinical data in the Commons can be shared with the appropriate security, privacy and compliance controls. To facilitate the rapid development of this critical resource, the OCC / University of Chicago team will contribute up to six months of engineering, bioinformatics and project management resources to the project and up to $500,000 of compute and storage resources for building the commons and for the use of the commons by the research community.

- Seven Bridges will contribute its experience in accelerating pharmaceutical research and development and in building national-scale research systems by developing the Blood Profiling Atlas Analysis Cloud, specifically tailored to the needs of the liquid biopsy community. This environment – based on the company’s work partnering with the NCI, Genomics England, the VA and others – will integrate with the Blood Profiling Atlas Commons, allowing molecular, clinical and imaging data to be easily, securely, and cost effectively analyzed by researchers across disciplines. In addition, Seven Bridges will share its expertise in cancer genomics and immunoinformatics analysis. To do so, the company will release algorithms for analyzing liquid biopsy data at scale, committing six months of engineering, bioinformatics and project management resources, and up to $500,000 compute and storage resources to facilitate use of the analysis tools and data donated by the Blood Profiling Atlas community.

- In support of the Blood Profiling Atlas, AstraZeneca will provide standard operating procedures for ctDNA isolation and library construction for targeted and whole genome/exome sequencing of ctDNA. The AstraZeneca bioinformatics pipeline for variant calling in ctDNA is available for all interested parties. Furthermore, AstraZeneca will generate ctDNA for comparative studies of other bioinformatics pipelines with the goal to develop best practices in identifying variants in ctDNA after high depth sequencing that will standardize analyses of data acquisition for the Atlas. AstraZeneca will additionally provide data on method comparisons and can assist in data generation for samples provided to this project.

- Celgene will contribute advanced analytic capabilities to the effort and sponsor a crowdsourced Challenge for patient benefit in the blood profiling domain. Celgene has...
“Working together, we got the job done” - Medical Innovation Game-Changer Now Law

Dec 13, 2016  Press Release

Signing Ceremony Marks Culmination of Three-Year Journey on the #Path2Cures

Delivering #CuresNow: Speaker Ryan Signs Bipartisan Game-Changing Medical Innovation Bill

Dec 8, 2016  Press Release

Bill Officially Heads to The White House to be Signed into Law
### Funding for NIH Innovative Research Initiatives under the Cures Act.

<table>
<thead>
<tr>
<th>Fiscal Year</th>
<th>BRAIN</th>
<th>PMI</th>
<th>Cancer Moonshot</th>
<th>Regenerative Medicine</th>
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<td>1,511</td>
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<td>1,800</td>
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* BRAIN denotes Brain Research through Advancing Innovative Neurotechnologies, and PMI Precision Medicine Initiative.
“To support cancer research, such as the development of cancer vaccines, the development of more sensitive diagnostic tests for cancer, immunotherapy and the development of combination therapies, and research that has the potential to transform the scientific field, that has inherently higher risk, and that seeks to address major challenges related to cancer...”

H.R.34—21st Century Cures Act
NCI Blue Ribbon Panel Report Recommendations

A. Establish a network for direct patient involvement
B. Create a clinical trials network devoted exclusively to immunotherapy
C. Develop ways to overcome cancer’s resistance to therapy
D. Build a national cancer data ecosystem
E. Intensify research on the major drivers of childhood cancers
F. Minimize cancer treatment’s debilitating side effects
G. Expand use of proven cancer prevention and early detection strategies
H. Mine past patient data to predict future patient outcomes
I. Develop a 3-D cancer atlas
J. Develop new cancer technologies

http://www.cancer.gov/brp
Cancer Moonshot℠ Funding vs. NCI Fiscal Year Funding

CANCER MOONSHOT: THE RESEARCH EXPRESS LANE

Cancer Moonshot funds will boost spending in fiscal year (FY) 2017 for selected areas of NCI's research portfolio. Experts identified these areas as poised for success—ripe for making near-term advances with potential for big impact. The Cancer Moonshot aims to accelerate progress and do in 5 years what would otherwise take 10 years.
NCI-Related Cancer Moonshot Activities

Through the Cancer Moonshot™, many new collaborations and activities have been launched that address barriers and opportunities in cancer research. NCI is involved in a number of these activities.

NCI-Related Activities Underway

National Cancer Institute Formulary

Leveraging lessons learned through the NCI-MATCH Trial, in which agents from different companies are tested alone or in combination under a single study, the institute is forging a public-private partnership with pharmaceutical and biotechnology companies to expedite cancer researchers’ access to investigational agents and approved drugs. Researchers from NCI-Designated Cancer Centers will be able to apply for access to agents from the available formulary list and test them in new preclinical or clinical studies, including combination studies of formulary agents from different companies. The NCI Formulary will alleviate the need

Proposed Activities with NCI Involvement

Create a high-quality performance status tracking system for cancer patients during therapy and long-term follow-up

A joint effort between NCI and DoD is aimed at improving the lives of cancer patients undergoing treatment, as well as members of the military attempting to complete a mission. Both cancer patients and military personnel suffer similarly from physical, physiological, and environmental stressors that affect their ability to perform as they each face potentially life-threatening challenges. An accurate, quantitative assessment could prevent doctors from sending patients for treatment they are not healthy enough to endure—and could help

https://www.cancer.gov/research/key-initiatives/moonshot-cancer-initiative/milestones/nci-activities
The National Cancer Institute (NCI) today launched a new drug formulary (the “NCI Formulary”) that will enable investigators at NCI-designated Cancer Centers to have quicker access to approved and investigational agents for use in preclinical studies and cancer clinical trials. The NCI Formulary could ultimately translate into speeding the availability of more-effective treatment options to patients with cancer.

The NCI Formulary is a public-private partnership between NCI, part of the National Institutes of Health, and pharmaceutical and biotechnology companies. It is also one of NCI’s efforts in support of the Cancer Moonshot, answering Vice President Biden’s call for greater collaboration and faster development of new therapies for patients. The availability of agents through the NCI Formulary will expedite the start of clinical trials by alleviating the lengthy negotiation process—sometimes up to 38 months—that has been required for investigators to access such agents on their own.

“The NCI Formulary will help researchers begin testing promising drug combinations more quickly, potentially helping patients much sooner,” said NCI Acting Director Douglas Lowy, M.D. “Rather than spending time negotiating agreements, investigators will be able to focus on the important research that can ultimately lead to improved cancer care.”

**Participating Companies (as of 01/11/2017)**

- Bristol-Myers Squibb
- Eli Lilly and Company
- Genentech
- Kyowa Hakko Kirin Co., Ltd.
- Loxo Oncology
- Xcovery Holding Company LLC
BCRF has awarded a team science grant to Drs. Shriver and Kuhn from the Department of Defense’s Murtha Cancer Center and the University of Southern California, while PCF is supporting Dr. Howard I. Scher of Memorial Sloan Kettering Cancer Center (MSKCC) and the Prostate Cancer Clinical Trials Consortium (PCCTC).

The funds have been awarded to recognized leaders in biomarker assay validation and are intended to support pilot projects that will utilize multiple technologies for analyzing rare events in the blood of cancer patients and subsequently deposit the data and associated protocols into the Blood PAC commons.
Lauren Leiman
Executive Director
lauren@bloodpac.org

ABOUT
BloodPAC

About

Overview

Data Matrices

Requires username and password.

- Data Submissions Count Matrix
- Detailed Project Matrix

Data Model

To facilitate a common set of standards and the use of tools for analysis, a data model has been developed for this project. We will work to make the data model as close to the Genomic Data Common (github.com/nci) data model as is compliant to the GA4GH standards as practicable.

https://github.com/nci-data/phenotype

- Overview of draft BPA data model v0.3
- Overview of draft BPA data model v0.5
- Overview of draft BPA data model v0.2
- Overview of draft BPA data model v0.1
- Browse the DDC data model
- Examine the DDC data model in detail
- BPA model in GitHub
- Clinical Data Harmonization
- Suggested templates for clinical experiment descriptions
Currently 9 opportunities addressing 4 BRP recommendations

Please check back regularly as additional Funding Opportunity Announcements are posted.

https://www.cancer.gov/research/key-initiatives/moonshot-cancer-initiative/blue-ribbon-panel/funding
A History of Cancer Chemotherapy

Vincent T. DeVita, Jr. and Edward Chu
Yale Cancer Center, Yale University School of Medicine, New Haven Connecticut

Figure 1. Key advances in the history of cancer chemotherapy

- **Special Virus Cancer Program** (1964)
- **Cure of ALL & Hodgkin’s disease (51–56, 63–66)** (1963–70)
- **Vinca alkaloids (50)** (1963)
- **Xenografts in nude mice** (1975)
- **Adjuvant chemotherapy (79–83)** (1968–75)
- **Cure of testicular cancer (86–88)** (1976)

**1971**: National Cancer Act

1984: NCI investment in molecular biology

1990: Cell culture systems

1995: Molecular profiling

2001: Genome sequenced

2005: Tyrosine kinase inhibitors (94–101)

2007: Target specific screens

2010: Mortality decline accelerates

1965: $640M (FY74)

1970: $5.21B (FY16)
Cancer Research Data Commons Ecosystem

Genomic Data Commons

Imaging Data Commons

Data Standards
Validation and Harmonization

Proteomics Data Commons

Clinical Data Commons (Cohorts / Indiv.)

SEER (Populations)

Blood Profiling Atlas Commons

Data Contributors and Consumers

Researchers

Institutions

Clinicians

Patients
Data Shared in Public Domain

Point-in-time Data

Data Shared among Partners Only

Longitudinal Data

Opportunity exists to generate publicly available longitudinal data to drive understanding of genetic mutations and find Precision Medicine cures

*Datasets have potential to include longitudinal data in the future

**Public/private information not available

***Serves as a portal also, has potential to include longitudinal data in the future

1. FoundationCore’s pediatric cancer data has been made public
Opportunity exists to generate publicly available longitudinal data to drive understanding of genetic mutations and find Precision Medicine cures.

- Datasets have potential to include longitudinal data in the future
- Public/private information not available
- Serves as a portal also, has potential to include longitudinal data in the future

1. FoundationCore’s pediatric cancer data has been made public
Big Data Scientist Training Enhancement Program (BD-STEP)

Graduates of BD-STEP would:

• have skillsets to perform next-generation patient-centered outcomes research by manipulating and analyzing large-scale, multi-element, patient data sets to develop novel disease signatures or unique performance-based clinical benchmarks

• have an understanding of real-time, performance-driven health care delivery in the VA systems

2017 Potential Partners:

Connie Lee, VHA/EES  Michelle Berny-Lang, NCI
CancerBase
Share, Discover & Change

Inviting those with cancer to join a global effort to make our data count. When patients share real-time data with patients, the world changes.

http://www.cancerbase.org
Acknowledgements/Thanks to the “Secret Ingredients”

Clinical Sciences

Life Sciences

Physical Sciences
Learn More About Us...

http://cssi.cancer.gov

Jerry S.H. Lee, PhD
jerry.lee@nih.gov