Summary of Inaugural Meeting and an Invitation to a Community in Action

October 25, 2018, 12-1 EST

• All lines are muted upon entry

• Pose your questions via the chat pod
  • Click on the “Send-to” drop-down and select EVERYONE, then submit your question

• Continue the conversation on Twitter: #MobilizeCBK
Summary of Inaugural Meeting and an Invitation to a Community in Action

Charles P. Friedman, PhD
University of Michigan

Rachel Richesson, PhD
Duke University

October 25, 2018
Today’s Webinar

Primarily a catch up for those who missed the July meeting.

• The Concept and Importance of Computable Biomedical Knowledge (CBK)
  • Learning Health Systems
  • The “Keystone” Role of CBK
  • Vision of a Computable Knowledge Ecosystem and a Community to Advance It

• Moving Forward
  • Review of July 2018 Meeting
  • Future Activities
  • Invitation to Get Involved
Better Health Through Learning Health Systems

Health systems—at any level of scale—become learning systems when they can, continuously and routinely, study and improve themselves.

Perspective: Jan 3, 2013
“Code Red and Blue — Safely Limiting Health Care’s GDP Footprint”
Arnold Milstein, M.D., M.P.H.

...U.S. health care needs to adopt new work methods, outlined in the Institute of Medicine’s vision for a learning health system...
Properties of a Health System That Can Learn & Improve

✓ A record of every health event is available to learn from

✓ Best practice knowledge is immediately available to support choices

✓ Improvement is continuous through ongoing study

✓ An infrastructure enables this to happen routinely and with economy of scale

✓ All of this is part of the culture
Learning Cycles: Better Health Requires a Flow

Interpret Results

Health Problem of Interest

Analyze

Assemble Data

D2K: Data to Knowledge

K2P: Knowledge to Performance

P2D: Performance to Data

Design Intervention

Take Action

Capture Practice as Data
Better Health Requires This:

- **D2K:** Data to Knowledge
- **K2P:** Knowledge to Performance
- **P2D:** Performance to Data

Health Problem of Interest
In Addition to This:

Health Problem of Interest

D2K: Data to Knowledge
K2P: Knowledge to Performance
P2D: Performance to Data

Journals
Persistent Computable Knowledge: The “Keystone” that Holds the Cycle Together

D2K: Data to Knowledge

K2P: Knowledge to Performance

Health Problem of Interest

P2D: Performance to Data
The Keystone Enables Discovery Systems to Become Learning Systems
Persistent Knowledge

• Knowledge: The result of an analytical and/or deliberative process that holds significance for an identified community.

• Persistence: An explicit representation exists at any point in time.

• Persistent ≠ Static

• Persistent knowledge can be represented in two ways:
  - human readable
  - machine-executable
Two Complementary Ways to Represent Knowledge

**Present:** Human readable in words & pictures

**Future:** Computable (machine-executable) in code

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**Library Holdings:** Books & Journals

**Library Holdings:** Will add Digital Knowledge Objects
Selection Criteria for Lung-Cancer Screening


ABSTRACT

BACKGROUND
The National Lung Screening Trial (NLST) used risk factors for lung cancer (e.g., ≥30 pack-years of smoking and <15 years since quitting) as selection criteria for lung-cancer screening. Use of an accurate model that incorporates additional risk factors to select persons for screening may identify more persons who have lung cancer or in whom lung cancer will develop.

METHODS
We modified the 2011 lung-cancer risk-prediction model from our Prostate, Lung, Colorectal, and Ovarian (PLCO) Cancer Screening Trial to ensure applicability to NLST data; risk was the probability of a diagnosis of lung cancer during the 6-year study period. We developed and validated the model (PLCO_{M2012}) with data from the 80,375 persons in the PLCO control and intervention groups who had ever smoked. Discrimination (area under the receiver-operating-characteristic curve [AUC]) and calibration were assessed. In the validation data set, 14,144 of 37,332 persons (37.9%) met NLST criteria. For comparison, 14,144 highest-risk persons were considered positive (eligible for screening) according to PLCO_{M2012} criteria. We compared the accuracy of PLCO_{M2012} criteria with NLST criteria to detect lung cancer. Cox models were used to evaluate whether the reduction in mortality among 53,202 persons undergoing low-dose computed tomographic screening in the NLST differed according to risk.
The New Knowledge is Expressed in a Model

<table>
<thead>
<tr>
<th>Variable</th>
<th>Odds Ratio (95% CI)</th>
<th>P Value</th>
<th>Beta Coefficient</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age, per 1-yr increase †</td>
<td>1.081 (1.057–1.105)</td>
<td>&lt;0.001</td>
<td>0.0778868</td>
</tr>
<tr>
<td>Race or ethnic group ‡</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>White</td>
<td>1.000</td>
<td>Reference group</td>
<td></td>
</tr>
<tr>
<td>Black</td>
<td>1.484 (1.083–2.033)</td>
<td>0.01</td>
<td>0.3944778</td>
</tr>
<tr>
<td>Hispanic</td>
<td>0.475 (0.195–1.160)</td>
<td>0.10</td>
<td>−0.7434744</td>
</tr>
<tr>
<td>Asian</td>
<td>0.627 (0.332–1.185)</td>
<td>0.15</td>
<td>−0.466585</td>
</tr>
<tr>
<td>American Indian or Alaskan Native</td>
<td>1</td>
<td></td>
<td>0</td>
</tr>
<tr>
<td>Native Hawaiian or Pacific Islander</td>
<td>2.793 (0.992–7.862)</td>
<td>0.05</td>
<td>1.027152</td>
</tr>
<tr>
<td>Education, per increase of 1 level †‡</td>
<td>0.922 (0.874–0.972)</td>
<td>0.003</td>
<td>−0.0812744</td>
</tr>
<tr>
<td>Body-mass index, per 1-unit increase †</td>
<td>0.973 (0.955–0.991)</td>
<td>0.003</td>
<td>−0.0274194</td>
</tr>
<tr>
<td>Chronic obstructive pulmonary disease (yes vs. no)</td>
<td>1.427 (1.162–1.751)</td>
<td>0.001</td>
<td>0.3553063</td>
</tr>
<tr>
<td>Personal history of cancer (yes vs. no)</td>
<td>1.582 (1.172–2.128)</td>
<td>0.003</td>
<td>0.4589971</td>
</tr>
<tr>
<td>Family history of lung cancer (yes vs. no)</td>
<td>1.799 (1.471–2.200)</td>
<td>&lt;0.001</td>
<td>0.587185</td>
</tr>
<tr>
<td>Smoking status (current vs. former)</td>
<td>1.297 (1.047–1.605)</td>
<td>0.02</td>
<td>0.2597431</td>
</tr>
<tr>
<td>Smoking intensity ‡</td>
<td></td>
<td></td>
<td>−1.822606</td>
</tr>
<tr>
<td>Duration of smoking, per 1-yr increase †</td>
<td>1.032 (1.014–1.051)</td>
<td>0.001</td>
<td>0.0317321</td>
</tr>
<tr>
<td>Smoking quit time, per 1-yr increase †</td>
<td>0.970 (0.950–0.990)</td>
<td>0.003</td>
<td>−0.0308572</td>
</tr>
</tbody>
</table>

* To calculate the 6-year probability of lung cancer in an individual person with the use of categorical variables, multiply the variable or the level beta coefficient of the variable by 1 if the factor is present and by 0 if it is absent. For continuous variables other than smoking intensity, subtract the centering value from the person’s value and multiply the difference by the beta coefficient of the variable. For smoking intensity, calculate the contribution of the variable to the model by dividing by 10, exponentiating by the power −1, centering by subtracting 0.4021541613, and multiplying this number by the beta coefficient of the variable. Add together all the previously calculated beta-coefficient products and the model constant. This sum is called the model logit. To obtain the person’s 6-year lung-cancer probability, calculate $e^{\text{logit}}/(1+e^{\text{logit}})$. CI denotes confidence interval.
Envisioning An Extended Publication Pipeline

Human Readable: Article

Extraction

Programming

Encodable: Model

Computable: Code

Library

Expanded Library
This Idea is “On the Street”

The Atlantic, 2018

National Library of Medicine, 2017


Use Cases for Computable Knowledge: CDS & Beyond

• **Clinical:** Present advice to inform decisions of providers & patients; evaluate treatments and measure performance for health organizations

• **Research:** Enhance scientific data & patient records, computable phenotypes, analytic “packages”

• **Public Health:** Event detection; deploy rapid response actions to threats; support behavior change and chronic disease management

• **Education:** Learning analytics, training for big data or ubiquitous knowledge environments
Making Knowledge FAIR

• Findable
• Accessible
• Interoperable
• Reusable

FROM: https://www.force11.org/group/fairgroup/fairprinciples
Approach to Knowledge FAIRness: Machine-executable Knowledge Objects

Guidelines

Articles

Local Analytical Results

Knowledge Objects

Description
Interface
Computer-processable Knowledge ‘Payload’
Next Generation Digital Libraries to Curate, Manage and Share Computable Knowledge
Networks of Digital Libraries Enable Computable Knowledge Ecosystem
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MCKB - Inaugural Public Meeting

July 10-11, 2018
Lister Hill National Center for Biomedical Communications
National Library of Medicine
Meeting Planning Committee

Julia Adler-Milstein, University of California San Francisco

Jane Blumenthal, University of Michigan Health Sciences Library

Greg Cooper, University of Pittsburgh

Milt Corn, National Library of Medicine

Chris Dymek, Agency for Healthcare Research and Quality

Peter Embi, Regenstrief Institute

Bob Greenes, Arizona State University

Nancy Lorenzi, Vanderbilt University Medical Center

Dan Masys, University of Washington

Blackford Middleton, Apervita, Inc.

Mark Musen, Stanford University

Jerry Perry, University of Arizona Health Sciences Library

Chris Shaffer, University of California San Francisco Parnassus Library

Umberto Tachinardi, University of Wisconsin- Madison

John Wilbanks, Sage Bionetworks

Co-chairs:

Charles Friedman, University of Michigan

Rachel Richesson, Duke University
Meeting Goals

• **Strengthen** our foundation of shared recognition of values and principles for mobilizing CBK

• **Frame** and address important dimensions for mobilizing CBK

• **Grow** the CBK community

• **Develop** Action Plans

• **Identify** priorities

• **Plan** next steps!!
Meeting Components

• Federal guest speakers
  • Dr. Don Rucker (ONC)
  • Dr. Patti Brennan (NLM)
  • Dr. Eric Dishman (NIH, *All of Us*)

• Manifesto Review and Reactor Panel
• Panel - State of the Art for CBK
• Poster Session, System Demos, & Reception
• Breakout Discussions – Developing Action Plans
  • Report & Synthesis
• “Open Mic”
• Summary and next steps
Mobilizing Computable Biomedical Knowledge (CBK):
A Manifesto

Preamble

Knowledge has the potential to improve health care, the health of individuals, and the health of populations. Every decision affecting health should be informed by the best available knowledge. For moral and ethical reasons, it is imperative that each and every member of society has access to what is known at the time they are making health-related choices and decisions.

It is no longer sufficient to represent knowledge in the form of printed words and static pictures. The increasingly rapid rate of scientific discovery needs knowledge representations that are more agile and amenable to scalability and mass action. This in turn can enable the continuous cycles of discovery and improvement envisioned as Learning Health Systems.

Contemporary digital technology enables knowledge to be represented in computable forms expressed in machine-executable code. Computable knowledge unleashes the potential of information technology to generate and deliver useful information—and particularly, decision-specific advice—to individuals and organizations with great speed on a world-wide scale. It is essential to take full advantage of these capabilities, while continuing established practices that validate knowledge, preserve it, and ensure that it can be trusted.

There is work to do to mobilize best available health knowledge for the greater good. To begin, biomedical knowledge in computable form must be made interoperable using open standards, and widely available so that it can be used to immediately impact health.

It is time for action on a global scale.

Computable Biomedical Knowledge

Computable Biomedical Knowledge is the result of an analytic and/or deliberative process about human health, or affecting human health, that is explicit, and therefore can be represented and reasoned upon using logic, formal standards, and mathematical approaches.

Vision

We are dedicated to:

Mobilizing biomedical knowledge that can support action toward improving human health. This should be done using computable formats that can be shared and integrated into health information systems and applications.

Efficiently and equitably serving the learning and knowledge needs of all participants, as well as the public good. This will work to significantly reduce health disparities.

https://goo.gl/RSW4jB ;
MobilizeCBK.org
Vision & Principles

• Mobilizing biomedical knowledge for action toward improving human health.

• Ensuring that the knowledge properly reflects the best and most current evidence and science.

• Ensure the safe and effective use of CBK through evolution of ecosystem with open standards and FAIR principles.

• Ensure methods to expose transparency and the currency, validity and provenance of CBK.

• Engender equity in health and in knowledge accessibility.
Breakout Groups and co-Chairs

• Standards
  - Mark Musen
  - Bob Greenes
  - Rachel Richesson

• Technical Infrastructure
  - Christopher Shaffer
  - Gregory Cooper

• Sustainability for Mobilization & Inclusion
  - Chris Dymek
  - Nancy Lorenzi
  - Jerry Perry

• Policy & Coordination to Ensure Quality & Trust
  - Blackford Middleton
  - Josh Richardson
  - Jodyn Platt
Standards

• Focus on metadata for important dimensions of CBK

• Develop a spanning set of use cases & knowledge-sharing scenarios
  • Examples of CBK artifacts and metadata.
  • Explore rationale for each element of metadata in the exemplars.
  • Identify existing metadata models.

• Possible future ideas: values, principles, process...
Technical Infrastructure

• Collaborate w/ and harmonize knowledge users
• Describe use cases and activity models in order to:
  • Identify infrastructure requirements
  • Identify “reference implementations”
  • Promote standards as services
  • Minimize # standards required
• Define meta-information about knowledge and its use
• Learn from other industries
• Establish governance infrastructure to help manage CBK ownership, intellectual property and access
Sustainability for Mobilization & Inclusion

- Energize and promote MCBK to diverse communities
- Articulate value proposition for CBK
- Define and execute plans to engage stakeholders:
  - Professional societies (e.g., AMA, ANA)
  - Patient advocacy groups
  - Clinical guideline organizations
  - Libraries
  - Industry vendors
Policy & Coordination to Ensure Quality & Trust

- Driving question: What is the process for ensuring high quality and trustworthy knowledge in a CBK ecosystem?

- Define and convey transparency in the CBK ecosystem
  - Understand current practices from other groups
  - Assemble, compare, and contrast metadata schema to identify gaps
  - Evaluate FAIR systems for transparency
  - Extend to FAIR-TLC (Traceability, Licensure, Connectedness)
  - Map the regulatory space
Transparency – Starting Ideals

• Make public all info & metadata about CBK to inform users to apply to specific use case
• Include limitations and derivatives
• Explicitly state COI; also values and tradeoffs

• Provide metadata for artifacts, dev. process, system, people, experience (implementation), sources, COI, legal parameters
• Capacity to “look under the hood”
• Employ user-centered design strategies for establishing trust
Decisions Made at Meeting

• Advance MCBK agenda, primarily through the 4 theme-based groups

• Develop supportive infrastructure (website, communication and outreach plans)

• Create webinar series

• Plan for 2\textsuperscript{nd} public meeting for summer 2019

• Interim “governance”
  • Meeting Planning Comm. \rightarrow Steering Committee
  • Univ. of Michigan interim home/resource hub
Working Groups Moving Forward

• Standards

• Technical Infrastructure

• Sustainability for Mobilization & Inclusion

• Policy & Coordination to Ensure Quality & Trust
Get involved!

• Website – MobilizeCBK.org
• Email – MCBK-Info@umich.edu

• Join a working group – complete the survey at or email us!

• Promote and attend upcoming webinars

• Plan to attend next MCBK meeting July 18-19, 2019
• Pose your questions via the chat pod
  • Click on the “Send-to” drop-down and select EVERYONE, then submit your question
• The moderator may unmute selected participants
• Continue the conversation on Twitter: #MobilizeCBK

www.MobilizeCBK.org