The App Store for Health: Coopting the Point of Care in the Era of the Affordable Care Act

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How do we learn from

“All the Patients . . . All the Time?”

(Instead of Some of the Patients All of the Time . . . )

. . . or really, just a couple of the patients, not that often.
- $48B investment in HIT
- $1.4B at Partners
- North of $0.5T total
- “1987 called and they want their EHR back”
Motivation: Innovation

Med-tastic is a well-funded NewCo which has developed an elegant medication list application that has physician and consumer facing functionality. Patients can annotate medication lists for accuracy.

To work, Med-tastic needs
  ✪ Prescribing history
  ✪ Dispensed medication history
  ✪ Allergies
  ✪ Problem list diagnoses
Escaping the EHR Trap — The Future of Health IT
Kenneth D. Mandl, M.D., M.P.H., and Isaac S. Kohane, M.D., Ph.D.

It is a widely accepted myth that medicine requires complex, highly specialized information-technology (IT) systems. This myth continues to justify soaring IT costs, burdensome physician workloads, and stagnation in innovation — while doctors become increasingly bound to documentation and communication products that are functionally decades behind those they use in their “civilian” life.

Even as consumer IT — word-processing programs, search engines, social networks, e-mail systems, mobile phones and apps, music players, gaming platforms — has become deeply integrated into the fabric of modern life, physicians find themselves locked into pre–Internet-era electronic health records (EHRs) that aspire to provide complete and specialized environments for diverse tasks. The federal push for health IT, spearheaded by the Office of the National Coordinator for Health Information Technology (ONC), establishes an information backbone for accountable care, patient safety, and health care reform. But we now need to take the next step: fitting EHRs into a dynamic, state-of-the-art, rapidly evolving information infrastructure — rather than jamming all health care processes and workflows into constrained EHR operating environments.

We believe that EHR vendors propagate the myth that health
WITHOUT ACCESS TO THE POINT OF CARE, EVERYTHING IS A ONE-OFF
Patient with TPMT Deficiency

DRISCOLL, ALEXANDER has a documented problem of TPMT - Thiopurine methyltransferase deficiency. Thiopurine methyltransferase (TPMT) is the enzyme responsible for the metabolism of mercaptopurine. Patients with TPMT - Thiopurine methyltransferase deficiency MAY require REDUCED doses of mercaptopurine.

Please page the Pharmacogenomics Service (pager #7454) if further information is required.
No Small Change for the Health Information Economy

Kenneth D. Mandl, M.D., M.P.H., and Isaac S. Kohane, M.D., Ph.D.

The economic stimulus package signed by President Barack Obama on February 17 included a $19 billion investment in health information technology. How can we best take advantage of this unprecedented opportunity to computerize health care and stimulate the health information economy while also stimulating the U.S. economy? A health care system adapting to the effects of an aging population, growing expenditures, and a diminishing primary care workforce needs the support of a flexible information infrastructure that facilitates innovation in wellness, health care, and public health.

Flexibility is critical, since the system will have to function under new policies and in the service of new health care delivery mechanisms, and it will need to incorporate emerging information technologies on an ongoing basis. As we seek to design a system that will constantly evolve and encourage innovation, we can glean lessons from large-scale information-technology successes in other fields. An essential first lesson is that ideally, system components should be not only interoperable but also substitutable.

The Apple iPhone, for example, uses a software platform with a published interface that allows software developers outside Apple to create applications; there are now nearly 10,000 applications that consumers can download and use with the common phone interface. The platform separates the system from the functional-
The App Store for Health

ONC Funded Research $15M Project under the “SHARP” program
Can EMRs behave like iPhones or Androids in that innovators readily create and widely distribute substitutable apps across thousands of installs?
Inspired by a

Design Challenge

18.12 Issue

Information is Beautiful

David McCandless
Intelligent Health Lab

State-of-the-Art ???

Cardio CRP

RESULT (+ = OUT OF RANGE) UNITS
0.4 mg/L

For Ages > 17 Years:

CCRP mg/L Risk According to AHA/CDC Guidelines
<1.0 Lower Relative Cardiovascular Risk
1.0-3.0 Average Relative Cardiovascular Risk
3.1-10.0 Higher Relative Cardiovascular Risk
Consider retesting in 1 to 2 weeks to exclude a benign transient elevation in the baseline CRP value secondary to infection or inflammation.

>10.0 Persistent elevations upon retesting, may be associated with infection and inflammation.
### Bloodwork Cardiology Result

**Patient info**
- **Name:** John Doe
- **Gender:** M
- **Age:** 49
- **DOB:** 01/10/1961
- **Ordered by:** Dr. Francis Pulaski
- **Collected:** 11/02/2010, 10:40 a.m.
- **Received:** 11/02/2010, 1:03 p.m.

#### About this test
This report evaluates your potential risk of heart disease, heart attack, and stroke.

#### Your results

<table>
<thead>
<tr>
<th>Test</th>
<th>Category</th>
<th>Level</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>CRP level test</td>
<td>Low risk (&lt;0.5 mg/L)</td>
<td>3.3</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Average (0.5-1.0 mg/L)</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>High risk (1.0-3 mg/L)</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>High risk of cardiovascular disease</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total cholesterol level</td>
<td>Desirable (&lt;200 mg/dL)</td>
<td>265</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Borderline (200-240 mg/dL)</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>High (&gt;240 mg/dL)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>LDL &quot;bad&quot; cholesterol</td>
<td>Near optimal (&lt;100 mg/dL)</td>
<td>233</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Near optimal (100-129 mg/dL)</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Borderline (130-159 mg/dL)</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>High (160-189 mg/dL)</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Very high (&gt;190 mg/dL)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>HDL &quot;good&quot; cholesterol</td>
<td>Low (&lt;40 mg/dL)</td>
<td>37</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Normal (40-60 mg/dL)</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>High (&gt;60 mg/dL)</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

#### Your risk
You show an elevated risk of cardiovascular disease.

- If you're a smoker with normal blood pressure (110/80 mmHg) but family history of heart attack before age 60 (one or both parents) your risk over 10 years is **15%**.
- **Your risk would be lowered**
  - 12% if your blood pressure were 120/80 mmHg
  - 10% if you quit smoking
  - 6% if you reduced cholesterol to 160mg/dL

Use your CRP results and cholesterol level to calculate your 10 year risk of a cardiovascular event at [ReynoldsRisk.org](http://ReynoldsRisk.org)

#### What now?
- **Diet & exercise** can improve your cholesterol levels
- **Quitting smoking** can decrease your heart disease risk by 50% or more
- **Ask your doctor** about statins or other medications that can lower cholesterol
- **Consider retesting** in 1 to 2 weeks to exclude a temporary spike in blood levels
1 Design + 1 Developer + 1 Week
1 SMART App in 3 SMART Systems
SMArt Prize for Patients, Physicians, and Researchers

Posted by Aneesh Chopra on March 10, 2011 at 03:02 PM EDT

This week a research team at Children’s Hospital of Boston and Harvard Medical School launched a prize to encourage innovative app developers to build new products and services that benefit patients and providers. The prize was created with funding from the Office of the National Coordinator for Health IT within the Department of Health and Human Services, and constitutes just the latest in a growing number of examples of the Federal government fostering R&D collaboration through open innovation.

The SMArt Prize competition could speed innovation in any number of areas. Developers might build a...
Intelligent Health Lab
Medication adherence

DRUG CLASS: ANTIHYPERTENSIVES

Furosemide 20 MG Oral Tablet

Predicted 1-year adherence level: Good

Actual MPR on day of last pill (day 210) is 0.857142857143

First fill date: Feb. 5, 2009; last fill date: Aug. 4, 2009

Ramipril 10 MG Oral Capsule

JAMIA 2011
Patient: Jose Martinez 11/21/2011

### Medicines you need to take every day:

<table>
<thead>
<tr>
<th>Medicine</th>
<th>Morning</th>
<th>Noon</th>
<th>Evening</th>
<th>Bedtime</th>
</tr>
</thead>
<tbody>
<tr>
<td>Diovan Tablet 160 mg</td>
<td></td>
<td>1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Aspirin Tablet 81 mg</td>
<td></td>
<td>1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Actos Tablet 30 mg</td>
<td></td>
<td>1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Lasix Tablet 40 mg</td>
<td>1/2</td>
<td></td>
<td>1/2</td>
<td></td>
</tr>
<tr>
<td>Glucophage Tablet 1000 mg</td>
<td></td>
<td></td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>Lipitor Tablet 40 mg</td>
<td></td>
<td></td>
<td></td>
<td>1</td>
</tr>
<tr>
<td>Advair Diskus 100/50 Inhaler</td>
<td>1 puff</td>
<td></td>
<td>1 puff</td>
<td></td>
</tr>
<tr>
<td>Potassium Chloride Powder 20 mEq/packet</td>
<td>1 packet</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

This medicine is used to treat high blood pressure.
This medicine helps to reduce blood clots.
This medicine is used to control blood sugar.
This medicine is used to help treat a weak heart.
This medicine is used to control blood sugar.
This medicine is used to control cholesterol in the blood.
This medicine is used to treat asthma.
This medicine is used to replace potassium in the body.

### Medicines you should take as needed:

<table>
<thead>
<tr>
<th>Medicine</th>
<th>Take the medicine by mouth every 6 hours.</th>
<th>Take one (1) pill each time.</th>
<th>This medicine is used to relieve pain.</th>
</tr>
</thead>
</table>

If you take any medicine that is not on this list, please tell your healthcare provider.
If you have questions about your medicines, please call 1-800-555-2422.
To view, update, or print your medication list, please go to www.dcinstructions.com. You will need the document ID and password (shown above).
### Decision Support Integration

e.g., Immunization Forecasting

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**Immunization Record SMART Application**

**Amy Shaw (female, DOB: 2007-03-20)**

<table>
<thead>
<tr>
<th>Vaccine</th>
<th>Due</th>
<th>Doses</th>
</tr>
</thead>
<tbody>
<tr>
<td>ROTAVIRUS</td>
<td>5/1/12</td>
<td>5/24/07</td>
</tr>
<tr>
<td>DTAP</td>
<td>3/1/12</td>
<td>9/22/07</td>
</tr>
<tr>
<td>HepB</td>
<td>1/2/12 - 2/1/12</td>
<td>9/27/07</td>
</tr>
<tr>
<td>POLIO</td>
<td>3/1/12</td>
<td>9/27/07</td>
</tr>
<tr>
<td>HPV</td>
<td>1/1/23 - 1/1/24</td>
<td></td>
</tr>
<tr>
<td>MENING</td>
<td>1/1/23 - 1/1/24</td>
<td></td>
</tr>
<tr>
<td>HepA</td>
<td>1/1/13 - 7/1/13</td>
<td></td>
</tr>
<tr>
<td>ZOSTER</td>
<td>Not indicated - Patient not yet indicated for ZOSTER vaccine</td>
<td></td>
</tr>
<tr>
<td>VARICELLA</td>
<td>1/1/13 - 4/1/13</td>
<td></td>
</tr>
<tr>
<td>HIB</td>
<td>3/1/12</td>
<td></td>
</tr>
<tr>
<td>MMR</td>
<td>1/1/13 - 4/1/13</td>
<td></td>
</tr>
<tr>
<td>Pneumocov</td>
<td>3/1/12 - 4/1/12</td>
<td></td>
</tr>
<tr>
<td>FLU</td>
<td>Not indicated - Current date is not within influenza season</td>
<td></td>
</tr>
</tbody>
</table>

---
### Intermittent Values

- **BP goal < 130/80**
- **LDL goal < 100**
- **AIC goal < 7**

### Last Known Values

<table>
<thead>
<tr>
<th>Metric</th>
<th>Value</th>
<th>Date</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Urine</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Ur 1.25</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Blood</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>SGT 1.0</td>
<td>37 U/L</td>
<td>12/5/10</td>
</tr>
<tr>
<td>GGT 1.0</td>
<td>46 U/L</td>
<td>12/5/10</td>
</tr>
<tr>
<td>Chol 1.0</td>
<td>148 mg/dL</td>
<td>03/16/11</td>
</tr>
<tr>
<td><strong>Fat</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Tri 1.0</td>
<td>222 mg/dL</td>
<td>03/16/11</td>
</tr>
<tr>
<td>HDL 1.0</td>
<td>53 mg/dL</td>
<td>03/16/11</td>
</tr>
<tr>
<td>LDL 1.0</td>
<td>72 mg/dL</td>
<td>03/16/11</td>
</tr>
<tr>
<td><strong>Lab</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>BUN 1.0</td>
<td>8.6 mg/dL</td>
<td>01/11/11</td>
</tr>
<tr>
<td><strong>Creatinine</strong></td>
<td>0.4 mg/dL</td>
<td>01/11/11</td>
</tr>
<tr>
<td>Glu 1.0</td>
<td>126 mg/dL</td>
<td>01/11/11</td>
</tr>
<tr>
<td><strong>AIC</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>AIC 1.0</td>
<td>8.6 %</td>
<td>02/14/11</td>
</tr>
<tr>
<td><strong>AIC</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>AIC 2.0</td>
<td>10.4 %</td>
<td>10/12/11</td>
</tr>
</tbody>
</table>

### Other Info

- **Weight**: 119.05/26/09
- **Height**: 48.99/28/11
- **Last Pneumovax**: 10/24/11
- **Flu Shot**

### Major CV Comorbidities

- Coronary artery disease
- Hypertension
- Heart disease
- **Diabetes**

### Medications

- **Rosuvastatin 10 mg Oral Tablet** [Crestor]: 1 qhs.
- **Chantix 40 mg Oral Tablet**: 1 qhs.
- **Clopidogrel 75 mg Oral Tablet** [Plavix]: 1 daily.
- **Pramipexole 0.3 mg Oral Tablet** [Mirapex]: 1 bid.
- **Metformin 500 mg Extended Release Tablet** [Glumetza]: 1 qhs.
- **Glyburide**: 1 mg Oral Tablet
- **Gliclazide 80 mg Oral Tablet** [Diamicron]: 1 daily.
- **Niaspan**: 1 qhs.
- **Statins**: 1 qhs.
- **Chantix**: 1 daily.
- **Celebrex**: 1 daily.

### Allergies

- None

### Reminders

- **Check blood pressure**
- **Check blood glucose**
- **Check cholesterol**
- **Check AIC today**
- **Check blood pressure**
- **Check blood glucose**
- **Check cholesterol**
- **Check AIC today**
- **Check blood pressure**
- **Check blood glucose**
- **Check cholesterol**
- **Check AIC today**

### Notes

- No known allergies.
“Merge App”
e.g., Microsoft HealthVault and Diabetes
Mashups: e.g., Genomic Medicine: There’s an App for that

- Linkage to external decision support services
  - Pharmacogenomic rule sets
  - Decision support for doctors—associations
Who's Who Of Health Care Join Forces For SMART Technology

In the new app-driven health economy, ease of use of IT for providers and patients is a must. Equally important is a sound technical approach and business plan for application creators looking for success, sustainability, and a large market for their innovations. Under the leadership of Boston Children's Hospital's Drs. Kenneth Mandl, Isaac Kohane, Joshua Mandel and an advisory

- Clayton Christensen, HBS
- Susanna Fox, Pew
- The Advisory Board Company
- AARP
- BMJ
- Canadian Institutes of Health Research
- Centers for Medicare and Medicaid Services
- Hospital Corporation of America
- Eli Lilly MyHealthBook
- Polyglot Systems
- Surescripts
- UK National Health Service
Intelligent Health Lab

TODAY IN PERSONAL JOURNAL

Big Data in the Doctor’s Office

PLUS The Price of Youth Sports

THE WALL STREET JOURNAL.

TUESDAY, MAY 13, 2014 - VOL. CCLXIII NO. 111

Nigerian Terrorists Parade Kidnapped Girls in Propaganda Video

Holder Makes Last Run
Figure: The Tapestry of Potentially High-Value Information Sources That May Be Linked to an Individual for Use in Health Care

**Types of Data**

**Structured Data**
- Medication
  - DTC medication
  - Medication filled
- Demographics
  - Employee sick days
  - Lab values, vital signs
- Encounters
  - Visit type and time
- Diagnoses
  - SNOMED, ICD-9
- Procedures
  - CPT, ICD-9
- Diagnostics (ordered)
  - LOINC, ECG
- Diagnostics (results)
  - Lab values, vital signs
- Genetics
  - SNPs, arrays
- Social History
  - Police records
- Family History
  - Ancestry.com
- Symptoms
  - Indirect from OTC purchases
- Lifestyle
  - Fitness club memberships, grocery store purchases
- Socioeconomic
  - Census records, Zillow, Linked in
- Social network
  - Facebook friends, Twitter hashtags
- Environment
  - Climate, weather, public health databases, HealthMap.org, GIS maps, EPA, phone GPS

**Probabilistic linkage to validate existing data or fill in missing data**

**Examples of biomedical data**
- Pharmacy data
- Health care center (electronic health record) data
- Claims data
- Registry or clinical trial data
- Data outside of health care system

**Ability to link data to an individual**
- Easier to link to individuals
- Harder to link to individuals
- Only aggregate data exists

**Data quantity**
- More
- Less

CPT indicates current procedural terminology; ECG, electrocardiography; EPA, US Environmental Protection Agency; GIS, geographic information systems; GPS, global positioning system; HL7, Health Level 7 coding standard; ICD-9, institutional Classification of Diseases. Ninth Revision; LOINC, Logical Observation Identifiers Names and Codes; NDC, National Drug Code; OTC, over-the-counter; SNOMED, Systematized Nomenclature of Medicine; SNP, single-nucleotide polymorphism.
Intelligent Health Lab

10 EHRs + 10 i2b2 Sidecars = SHRINE Query for Network-wide Patient List

Data Returns to Side Car

SCILHS Clinical Data Research Network

- Partners Healthcare System
- Boston Children’s Hospital
- Beth Israel Deaconess Med Ctr
- Boston Health Net (BMC and Community Health Centers)
- Columbia U. Medical Center and New York Presbyterian Hospital
- Cincinnati Children’s Hospital
- Wake Forest Baptist Medical Center
- Morehouse/Grady/RCMI
- U Mississippi Medical Center/RCMI
- U Texas Health Science Center/Houston

+ 10 i2b2 Sidecars

SMART Apps for:
- Patient Review
- Trial Matching
- Contact
- Surveys
- PRO Collection

= SHRINE Query for Network-wide Patient List
18 Month Work Period: Standing High Jump will Not Clear
The Plan

Common data platform *(i2b2)*

+ Federated queries across sites *(SHRINE)*

+ Point of care apps *(SMART)*

+ Patient-facing technologies *(RedCap, SMART, +)*
Contact

Kenneth_Mandl@Harvard.edu