Moving AI to the Point of Care

Kenneth D. Mandl, MD, MPH

Director, Computational Health Informatics Program
Boston Children’s Hospital

Donald A.B. Lindberg Professor of Pediatrics
Professor of Biomedical Informatics
Harvard Medical School

@mandl
Despite $48B Investment in EHRs, Point of Care is a Walled Garden
Invention of the World Wide Web

- Built over the existing TCP and IP protocols, it consisted of 4 building blocks:
  - A textual format to represent hypertext documents, the *HyperText Markup Language* (HTML).
  - A simple protocol to exchange these documents, the *Hypertext Transfer Protocol* (HTTP).
  - A client to display these documents, the first Web browser called *WorldWideWeb*.
  - A server to give access to the document, an early version of *httpd*. 
Parsimonious Standards to Create Interop

1. Substitutable apps
2. Trigger-able decision support
3. Patient-generated data
4. Push button population health
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-
No Small Change for the Health Information Economy

The economic stimulus package signed by President Barack Obama on February 17 included a $39 billion investment in health information technology. How can we best take advantage of this unprecedented opportunity to transform health care and stimulate the health information economy while also attaining the U.S. economic health care delivery systems, and it will need to incorporate emerging information technologies on an ongoing basis. As we seek to design a system that will work to reduce, it needs to integrate and encourage innovation, we can plan lessons from large-scale information-
Problem #1

AI apps don’t connect to health systems data
Certification Requirement

‘has published application programming interfaces and allows health information from such technology to be accessed, exchanged, and used without special effort through the use of application programming interfaces or successor technology or standards, as provided for under applicable law, including providing access to all data elements of a patient’s electronic health record to the extent permissible under applicable privacy laws;
A commercially viable app

<table>
<thead>
<tr>
<th>Drug Name</th>
<th>SIG Instructions</th>
<th>Links</th>
<th>Med Type</th>
<th>Category</th>
<th>Cal</th>
<th>PMI</th>
</tr>
</thead>
<tbody>
<tr>
<td>Aspirin Tablet 81mg</td>
<td>1 once daily [morning] for preventing blood clots in the legs</td>
<td></td>
<td>Oral Pill</td>
<td>Daily</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Carvedilol Tablet 25mg</td>
<td>1 twice daily</td>
<td></td>
<td>Oral Pill</td>
<td>Daily</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Fish Oil Capsule 1000mg</td>
<td>2 once daily</td>
<td></td>
<td>Oral Pill</td>
<td>Daily</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Flovent 100mcg/Inh</td>
<td>1 puff every 12 hours</td>
<td></td>
<td>Inhalant</td>
<td>Daily</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Irbesartan Tablet 300mg</td>
<td>1 once daily</td>
<td></td>
<td>Oral Pill</td>
<td>Daily</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Metamucil Sugar-Free</td>
<td>1 teaspoon three times daily</td>
<td></td>
<td>Oral Liquid</td>
<td>Daily</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Omeprazole Delayed Release Tablet 20mg</td>
<td>1 once daily</td>
<td></td>
<td>Oral Pill</td>
<td>Daily</td>
<td></td>
<td></td>
</tr>
<tr>
<td>ProAir HFA</td>
<td>2 puffs every 4 hours for asthma</td>
<td></td>
<td>Inhalant</td>
<td>Daily</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Synthroid Tablet 50mcg</td>
<td>1 once daily</td>
<td></td>
<td>Oral Pill</td>
<td>Daily</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Systane ophthalmic solution</td>
<td>1 drop each eye twice daily</td>
<td></td>
<td>Ophthalmic</td>
<td>Daily</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Vitamin D3 Capsule 5000iu</td>
<td>1 once daily</td>
<td></td>
<td>Oral Pill</td>
<td>Daily</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Zetia Tablet 10mg</td>
<td>1 once daily</td>
<td></td>
<td>Oral Pill</td>
<td>Daily</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
The App Gallery

MedicationRS is accessed from within EHR workflow and converts patients’ complex medication instructions into plain language for low health literate and limited English proficient patients. Low health literate individuals are more likely to take their medicines incorrectly, be hospitalized, mismanage chronic conditions and visit the emergency room.

Medication reduces medication errors and improves medication adherence by providing actionable Sig-based instructions. Medication is not static patient education material (PIM). Medication uses the patient’s medication and Sig information for integrated with your EHR or Pharmacy system. Medication uses a patient’s medications and Sig information to create personalized medication instructions that can be delivered to patients printed, or as part of their discharge documents, without interrupting clinical workflow. Medication has proven to increase medication adherence, improve patient satisfaction and reduce hospital readmission rates, particularly for Low Health Literate and Limited English Proficient patients.

Medication Instructions and summaries:
- Are at a 5th-grade reading level for patients with literacy issues
- Summarize patients’ complex medication regimens in a single page
- Provide detailed instructions for 5000+ medications and more than 150,000 NDC codes
- Offer 6 font size choices, for the elderly or vision-impaired
- Unambiguously depict the patient’s specific Sig (prescription dose and frequency) using the “Universal Medication Schedule”
- Include pictograms depicting usage, to reduce dosing errors.
- Link to a library of multilingual videos that demonstrate proper use of particularly difficult devices or medications.
- Are all available in 20+ languages for limited English proficient patients
- Present information in research-based, engaging and intuitive formats that reduce cognitive overload

Designed for
- Clinicians & Patients

FHIR Compatibility
- DSTU 2, DSTU 3

Categories
- AMIA 2018, Patient Engagement, Medication

License & Pricing
- Other, Site-licensed, Per User

Call (800) 633-3453 and select option #6 to speak with a sales consultant.

EHR Support: Epic, Cerner, Allscripts

© Boston Children’s Hospital 2017

JMIR 2019
Problem #2

Can’t launch apps at just the right moment during the decision process
Triger-able decision support

1. EHR triggers a CDS hook and invokes a remote service.

2. CDS Service executes its own rules, leveraging FHIR data as needed.

3. Returns CDS cards (rendered and displayed by EHR).

- EHR Med Order
  - Toprol XL
  - 50 mg daily

- Information card
  - $200 per month (patient pays $30)

- Suggestion card
  - Try HCTZ as first-line
  - Switch to HCTZ

- Smart app link card
  - Managing hypertension?
  - Launch JNC 8 Rx Pro
Patient generated data are non-standardized and in a separate silo
Modularity of software and sensor products to detect atrial fibrillation through connected technologies

<table>
<thead>
<tr>
<th>Operating System (OS)</th>
<th>Sensor Data Collection (&quot;Raw&quot; Data)</th>
<th>Algorithm Signal Data Processing</th>
<th>Algorithm to Inform, Diagnose, and/or Intervene/Treat</th>
<th>User Interface &amp; User Experience</th>
</tr>
</thead>
<tbody>
<tr>
<td>AliveCor</td>
<td>AliveCor KardiaBand for Apple Watch</td>
<td>Apple OS, Apple Watch</td>
<td>AliveCor App &amp; Afib algorithm</td>
<td></td>
</tr>
<tr>
<td>CardioGram</td>
<td>Hardware &amp; OS Agnostic</td>
<td></td>
<td>Cardiogram App &amp; Afib algorithm</td>
<td></td>
</tr>
<tr>
<td>Apple</td>
<td>Apple OS, Apple Watch</td>
<td></td>
<td>Apple PPG Analysis SaMD Algorithm</td>
<td>Apple OTC ECG SaMD App</td>
</tr>
<tr>
<td>Fitbit</td>
<td>Smartphone OS Agnostic</td>
<td>Fitbit Hardware</td>
<td>Fitbit App, Purepulse Data, &amp; Afib algorithm</td>
<td></td>
</tr>
<tr>
<td>Xiaomi</td>
<td>Smartphone OS Agnostic</td>
<td>Xiaomi Heart Rate Sensor &amp; Data Processing</td>
<td>API open to Developers</td>
<td>MI Fit App</td>
</tr>
</tbody>
</table>

NPG Digital Medicine 2019
The SMART Markers Framework (coming soon)
Problem #4

Getting reference population data (for model building, updating) out of EHRs into analytic platforms is really hard
Push button population health /FLAT FHIR

- Enhancing FHIR to
- Support Bulk Data access

CMS
CENTERS FOR MEDICARE & MEDICAID SERVICES

Google
Establish your independent research program at Harvard and Boston Children’s

Harvard Medical School Instructor, Assistant, or Associate Professor

in the

Computational Health Informatics Program

@mandl

www.chip.org