Building the App Store for Biosurveillance

Kenneth D. Mandl, MD, MPH

Director, Intelligent Health Laboratory
Boston Children's Hospital Informatics Program (CHIP)
Harvard Center for Biomedical Informatics
Co-Director CDC Center of Excellence in Public Health Informatics

HOW DO WE BI-DIRECTIONALLY LINK BETWEEN PUBLIC HEALTH AND THE POINT OF CARE?

NATIONAL STRATEGY FOR BIOSURVEILLANCE

"Providing information to the health care system can substantially benefit decisions regarding patient treatment, infection control measures, and hospital staffing."

JULY 2012

Use Case 1—Delivering General Alerts to the EMR

* Reuters is not responsible for the content in this press release.

Mon Feb 21, 2011 8:00am EST

CDC to Test Actionable Alerts with GE Healthcare

A GE Healthcare, Alliance of Chicago and CDC Collaboration Project

After a full year of feasibility studies, the Centers for Disease Control and Prevention (CDC) is taking a significant step toward providing public health information at the point-of-care. CDC is collaborating with GE Healthcare, a unit of General Electric Company (NYSE: GE), to explore the efficacy of actionable health alerts, delivered instantly to a physician's electronic medical record.

"When a physician is seeing a patient, she just punches the data in as she normally would," explained Dr. Mark Dente, Chief Medical Informatics Officer for GE Healthcare IT. "The real work happens behind the scenes."

Once the data is entered, it's de-identified and transmitted to an archive where it's measured against a disease profile and, where a suitable match is found, the relevant alert is issued and appears on the doctor's EMR (Electronic Medical Record) display without so much as an extra keystroke.

"Our first use case explores foodborne illness—and CDC estimates there are 48 million cases of it in the US alone each year," explained Dente. "As symptoms are captured by the computer, CDC matches them

The Problem

The NEW ENGLAND JOURNAL of MEDICINE

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 steps: 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

ORIGINAL CONTRIBUTION

Current stage technologies: No data in or out, no communication

Role of Computerized Physician Order Entry Systems in Facilitating Medication Errors

Ross Koppel, PhD
Joshua P. Metlay, MD, PhD
Abigail Cohen, PhD
Brian Kinderick, BS
S. Russell Localio, JD, MPH, MS
Stephen E. Kimmel, MD, MSCE
Brian L. Strom, MD, MPH

Context Hospital computerized physician order entry (CPOE) systems are widely regarded as the technical solution to medication ordering errors, the largest identified source of preventable hospital medical error. Published studies report that CPOE reduces medication errors up to 81%. Few researchers, however, have focused on the existence or types of medication errors facilitated by CPOE.

Objective To identify and quantify the role of CPOE in facilitating prescription errors.

Design, Setting, and Participants We performed a qualitative and quantitative study of house staff interaction with a CPOE system at a tertiary-care teaching hospital (2002-2004). We surveyed house staff (N = 261; 88% of CPOE users), conducted 5 focus groups and 10 intensive one-on-one interviews with house staff, information technology leaders, pharmacy leaders, attending physicians, and nurses, shadowed house staff and nurses, and observed them using CPOE. Participants included house staff, nurses, and hospital leaders.

Main Outcome Measure Examples of medication errors caused or exacerbated by the CPOE system.

Results We found that a widely used CPOE system facilitated 22 types of medication error risks. Examples include fragmented CPOE displays that prevent a coherent view of patients' medications, pharmacy inventory displays misleading for dosage guidelines, ignored antibiotic renewal notices placed on paper charts rather than in the CPOE system, separation of functions that facilitate double dosing and incompatible orders, and inflexible ordering formats generating wrong orders. Three quarters of the house staff reported observing each of these error risks, indicating that they occur weekly or more often. Use of multiple qualitative and survey methods identified and quantified error risks not previously considered, offering many opportunities for error reduction.

Conclusions In this study, we found that a leading CPOE system often facilitated medication error risks, with many reported to occur frequently. As CPOE systems are implemented, clinicians and hospitals must attend to errors that these systems cause in addition to errors that they prevent.

As per the National Coordinator . . .

- New England Journal of Med 2008: Low uptake of HIT in ambulatory setting
- New England Journal of Med 2009 Low uptake in of HIT in hospitals

Conclusion: $48B investment, pushing the technology

Medicare Meaningful Use Incentive Payment Schedule

Calendar Year	First Calendar Year in which the Eligible Professional Receives an Incentive Payment				
	2011	2012	2013	2014	2015 +
2011	$18,000	------	------	------	------
2012	$12,000	$18,000	------	------	------
2013	$8,000	$12,000	$15,000	------	------
2014	$4,000	$8,000	$12,000	$12,000	------
2015	$2,000	$4,000	$8,000	$8,000	$0
2016	------	$2,000	$4,000	$4,000	$0
TOTAL	$44,000	$44,000	$39,000	$24,000	$0

Cap applies for any eligible professional with at least $24,000 in Medicare Part B allowable charges in each payment year

Illustration: An Innovator who cannot reach scale

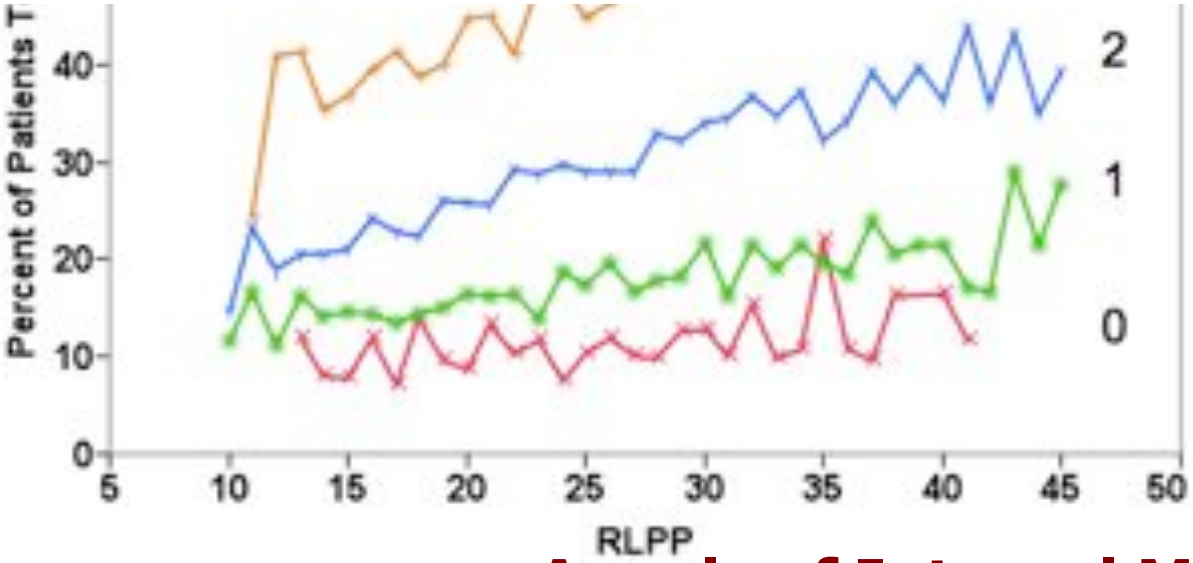
Med-tastic is a well-funded NewCo which has developed an elegant medication list application that has physician and consumer facing functionality

To work, Med-tastic needs

- Prescribing history
- Dispensed medication history
- Allergies
- Problem list diagnoses

Use Case 2: Delivering Context Sensitive Information to the Point of Care

"Reverse Biosurveillance"



Annals of Internal Med 2011

Use Case 3: Case Identification and Reporting

Use Case 4: Context sensitive Information in a Crisis

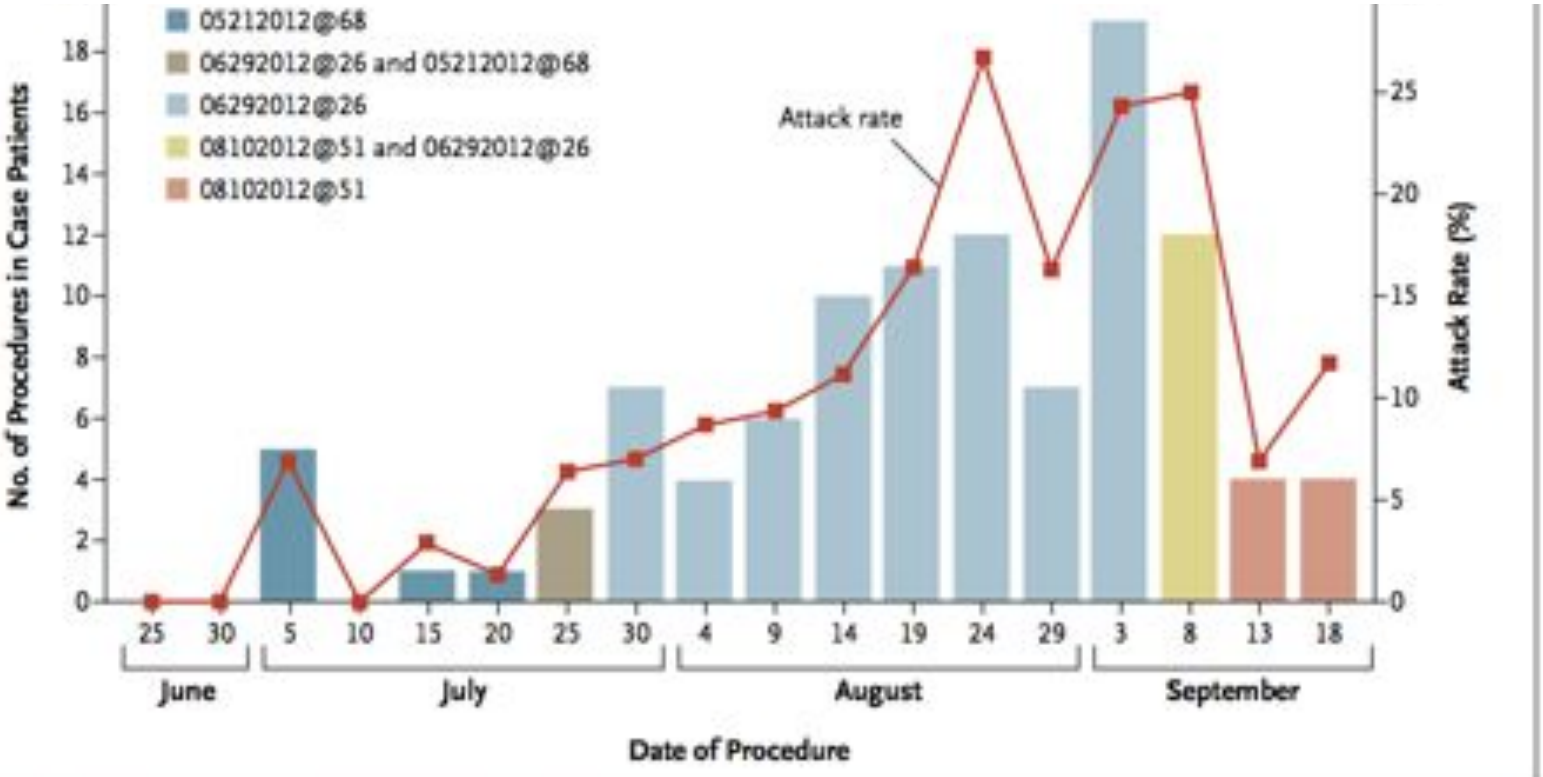
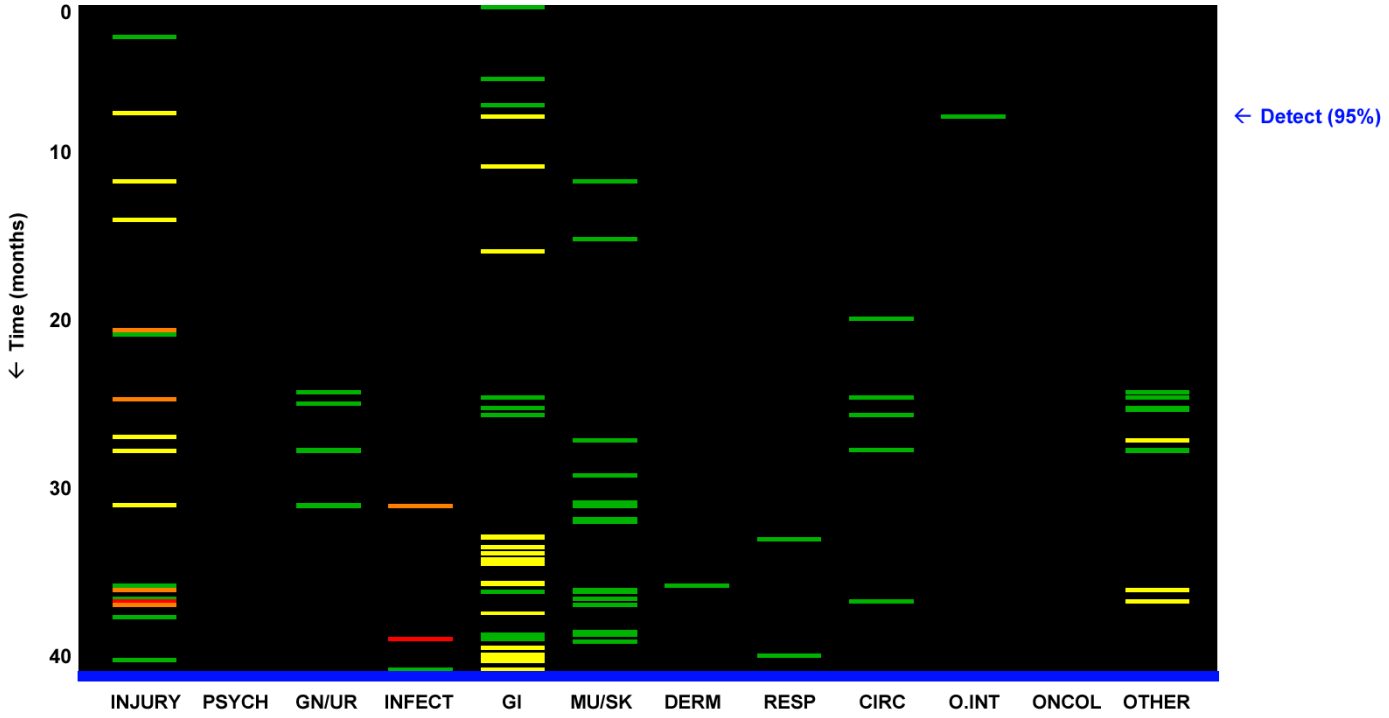


Figure 1. Number of Epidural and Paraspinal Glucocorticoid Injections and Attack Rate.

Shown are the number of epidural and paraspinal glucocorticoid injection procedures performed in case patients, as well as the attack rates among persons who received methylprednisolone acetate from the implicated lots during

Use Case 5: Predictive Medicine/ Public Health Screening

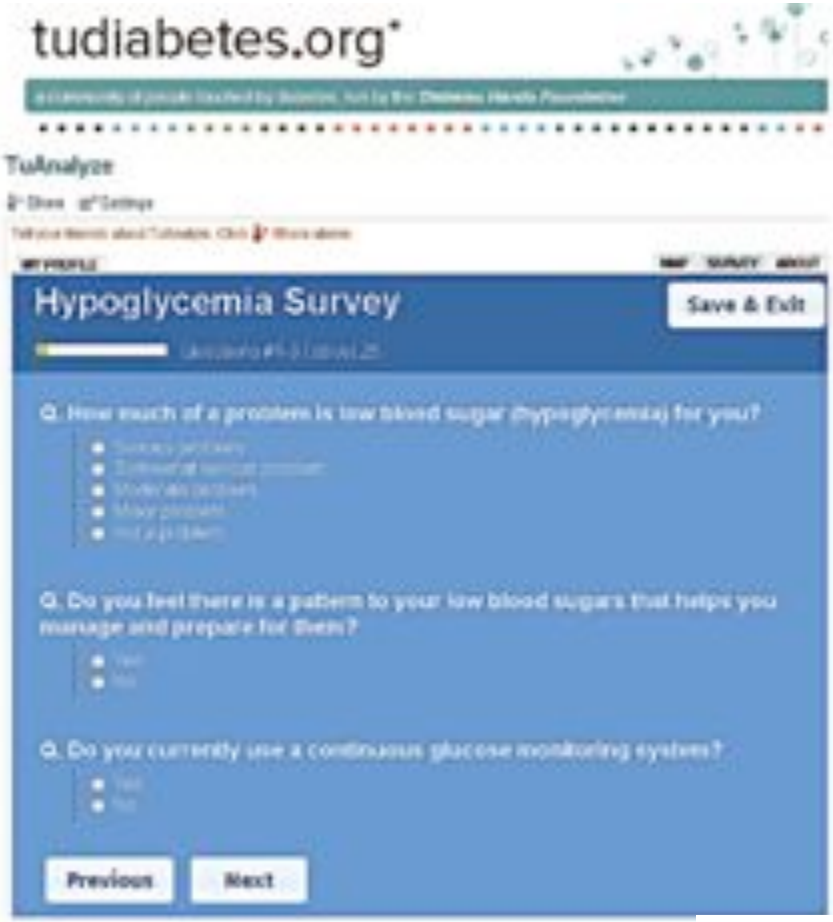
Domestic Violence

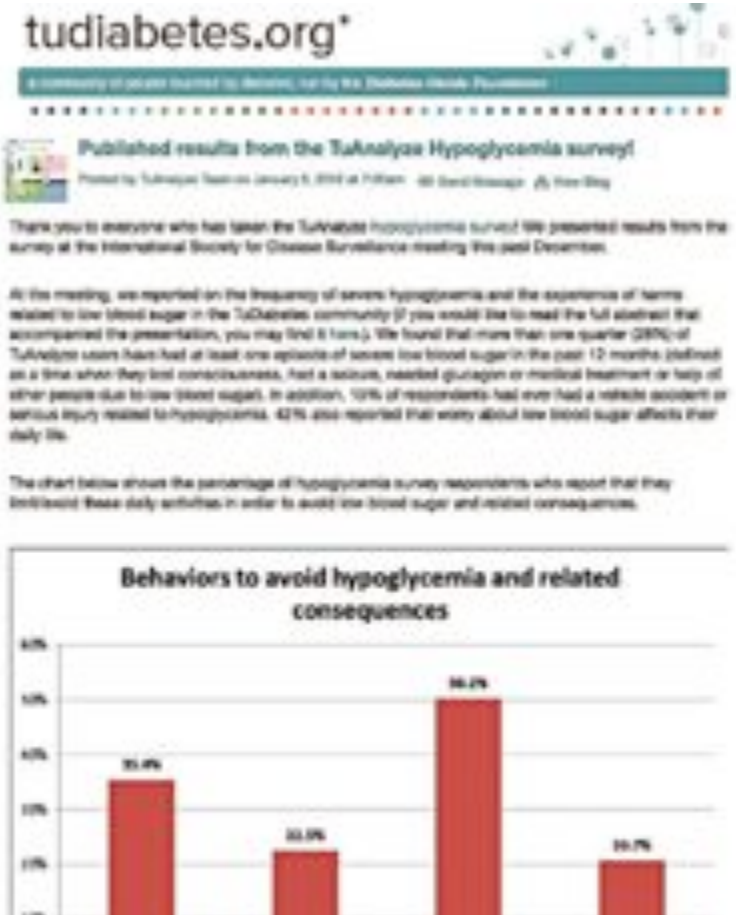


British Medical Journal

Use Case 6:
CDC Updates immunization schedule updated

Use Case 7—Direct Patient Engagement





JAMA Internal Medicine 2013

An Integrated Public Health and Health Care System

- How do we get public health to the point of care?
  - ✓ Deliver Alerts
  - ✓ Provide contextualized information to guide treatment
  - ✓ Automatically identify and report cases
  - ✓ Drill down into history while the patient is present
  - ✓ Nimbly update decision support rules

The New York Times

“There’s no way small practices can effectively implement electronic health records on their own.”

“This is not the iPhone.”

The NEW ENGLAND JOURNAL of MEDICINE

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 apps across thousands of installs?

The Core Team

- Co-Directors, PI's
  - ✓ Isaac Kohane, Ken Mandl
- Principal Architect
  - ✓ Joshua Mandel
- Lead Developer
  - ✓ Nikolai Schwertzner
- Executive Director
  - ✓ Rachel Ramoni
- Executive Committee
  - ✓ Shawn Murphy
  - ✓ Elmer Bernstam
  - ✓ Mike McCoy
  - ✓ Griffin Weber
- Advising Architect
  - ✓ Ben Adida
- Business Consultant
  - ✓ David Kreda
- External Evaluator
  - ✓ Patti Brennan

Advisory Committee

- Clayton Christensen
  - ✓ Harvard Business School
- David Clark
  - ✓ MIT CSAIL
- James Daniel
  - ✓ ONC
- Jim Hansen
  - ✓ Dossia
- Mark Frisse
  - ✓ Vanderbilt University
- John Glaser
  - ✓ Siemans Health Services Business Unit
- Ron Gutman
  - ✓ HealthTap
- John Halamka
  - ✓ HITSP, HIT Standards Committee
- Regina Herzlinger
  - ✓ Harvard Business School
- David Kibbe
  - ✓ Kibbe Consulting
- Timothy Kurth
  - ✓ CVS/CareMark
- Ken Majkowski
  - ✓ Surescripts
- David McCallie
  - ✓ Cerner
- Sean Nolan
  - ✓ Microsoft Health Solutions Group
- Ed Park
  - ✓ Athena Health
- Doug Solomon
  - ✓ IDEO
- Ann Waldo
  - ✓ Oldaker, Belair, and Wittie, LLP

Substitutability

- Substitutable apps. The purchaser of an application can replace one for another without being technically expert
- Substitutable containers. The application can run on any platform that has implemented the API

Substitutability is an overarching principle to drive interoperability—the data must be presented in the same precise format by the "container" each time

In a sense, there is a virtuous cycle in which good standards (or when necessary, new standards) become used to support apps, and successful apps then reinforce the standards (or create *defacto* new standards)

Our vocabulary

- **Data Sources**

  Managed by containers

- **Containers**

  Present data from data sources to apps in a uniform fashion

- **Apps**

  Completely substitutable

UI

Standards-based integration (HTML5)

Data

Context (container, user, patient)

Medical (Problems, Allergies, etc.)

API

Resource oriented, everything gets a **URL**

Authentication

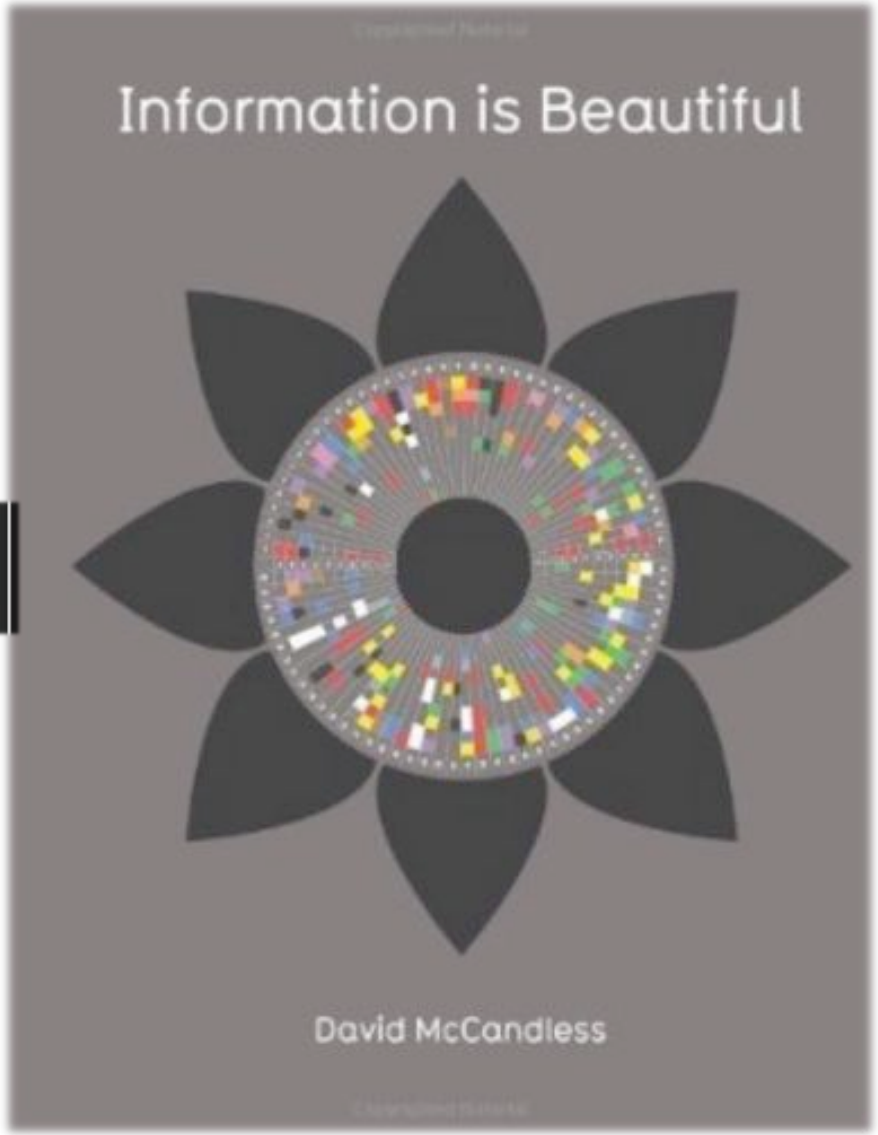
Consistent delegation with Web standards (OAuth)

Inspired by a

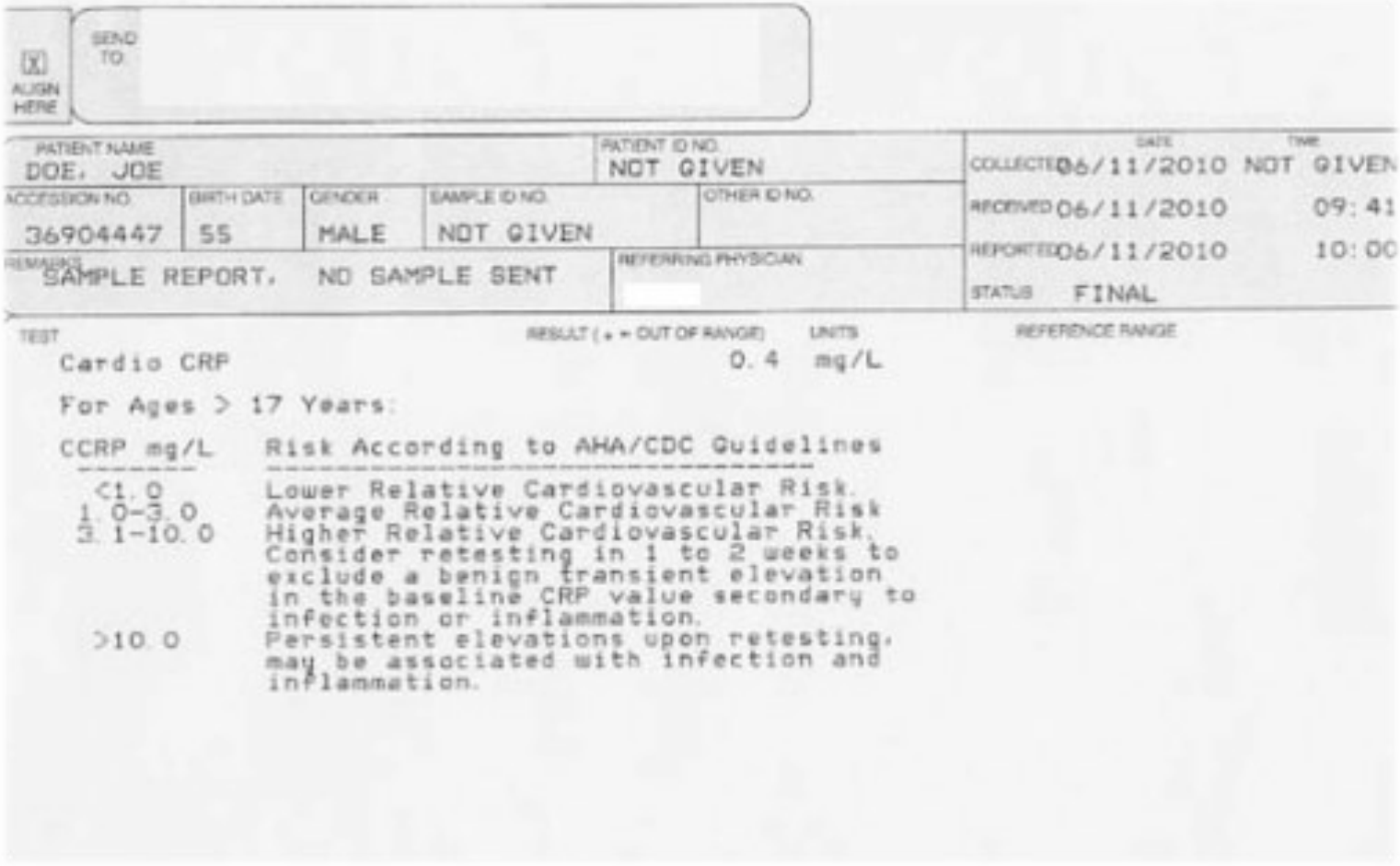
WIRED

18.12 Issue

Design Challenge



State-of-the-Art ???



[X] ALIGN HERE

SEND TO

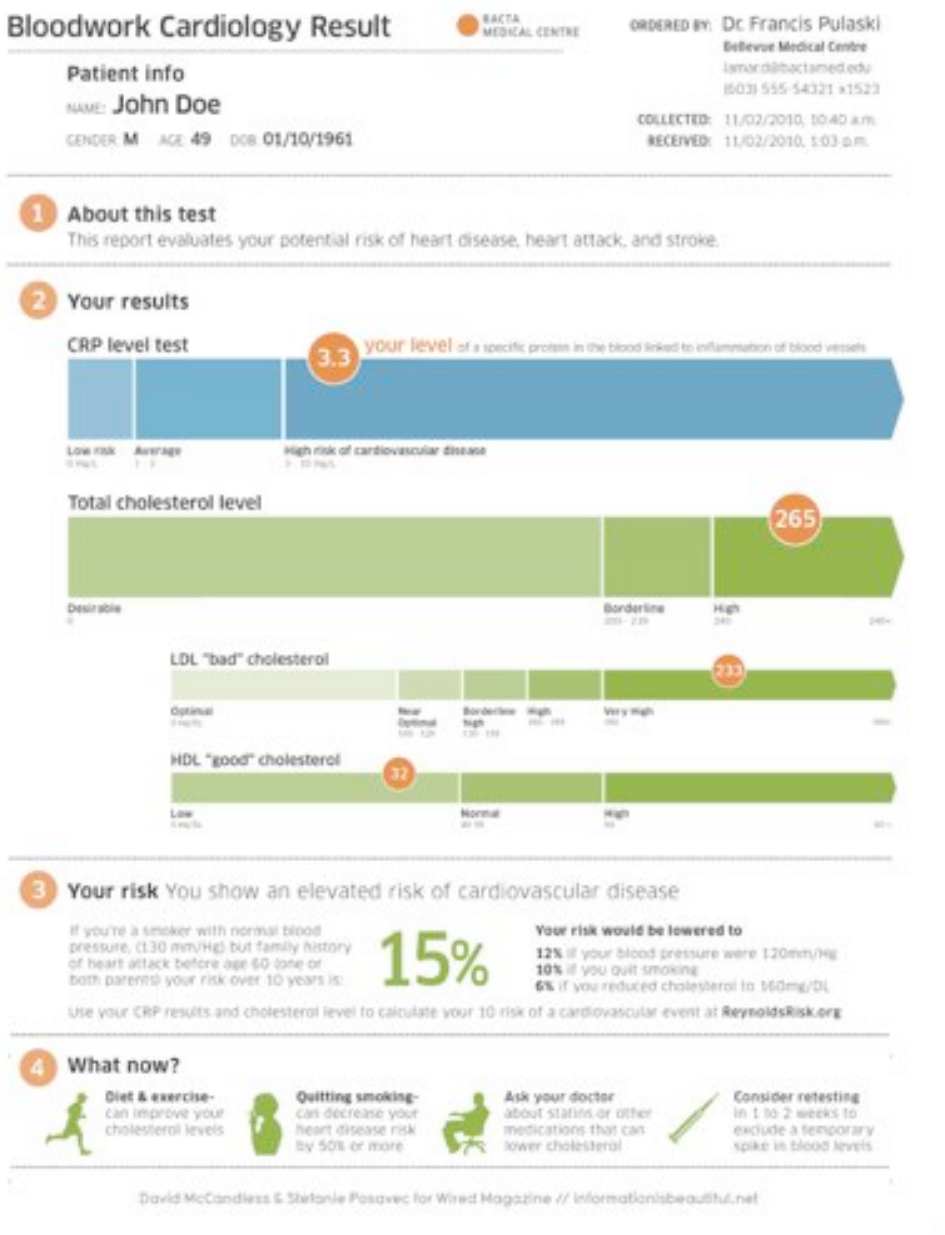
PATIENT NAME				PATIENT ID NO.		DATE	TIME
DOE, JOE				NOT GIVEN		COLLECTED 06/11/2010	NOT GIVEN
ACCESSION NO.	BIRTH DATE	GENDER	SAMPLE ID NO.		OTHER ID NO.	RECEIVED 06/11/2010	09:41
36904447	55	MALE	NOT GIVEN			REPORTED 06/11/2010	10:00
REMARKS SAMPLE REPORT, NO SAMPLE SENT			REFERRING PHYSICIAN			STATUS FINAL	

TEST	RESULT (* = OUT OF RANGE)	UNITS	REFERENCE RANGE
Cardio CRP	0.4	mg/L	

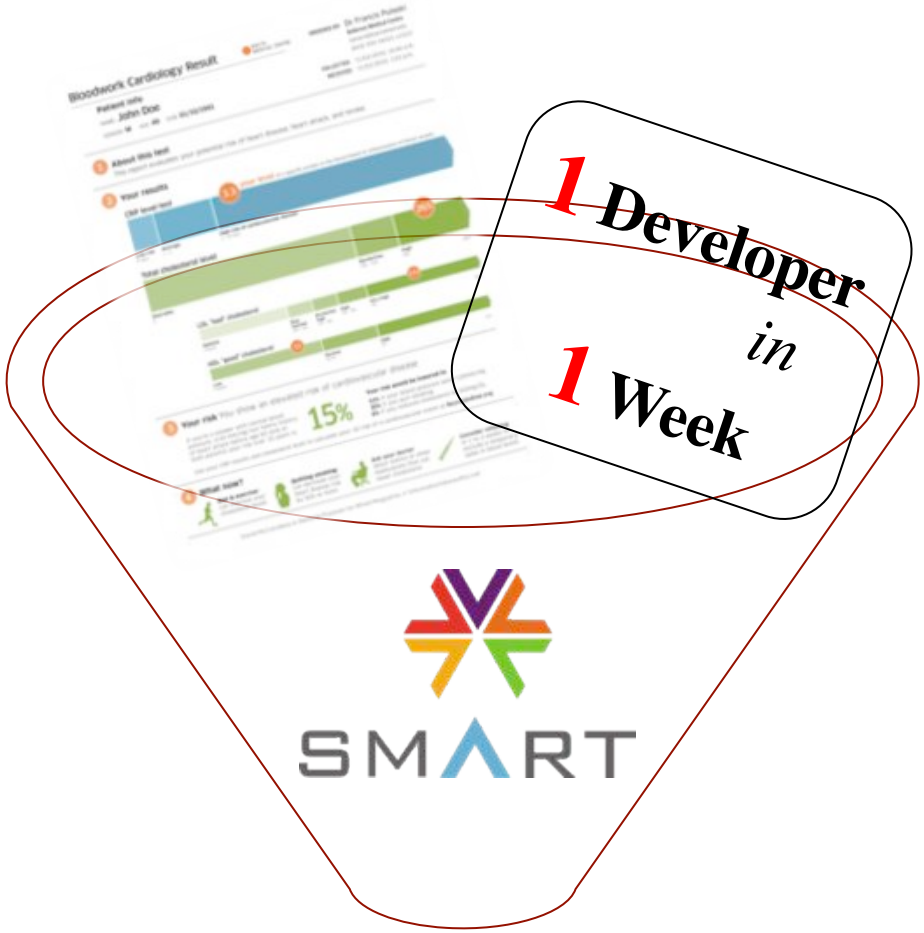
For Ages > 17 Years:

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.

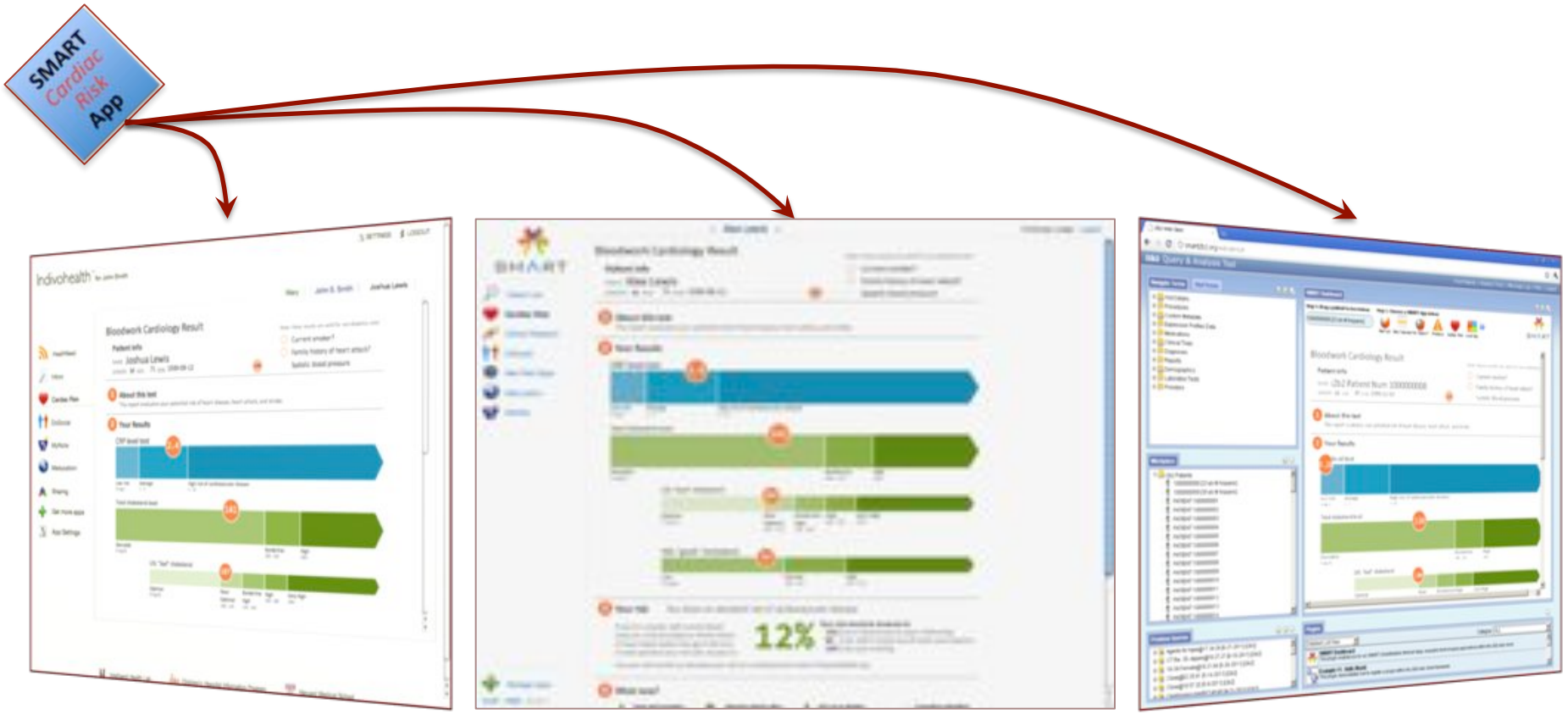
An
Inspired Design
from Dave McCandless
(cc license)



1 Design + 1 Developer + 1 Week



1 SMART App in 3 SMART Systems



Well-publicized

the WHITE HOUSE PRESIDENT BARACK OBAMA

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SMArt Prize for Patients, Physicians, and Researchers

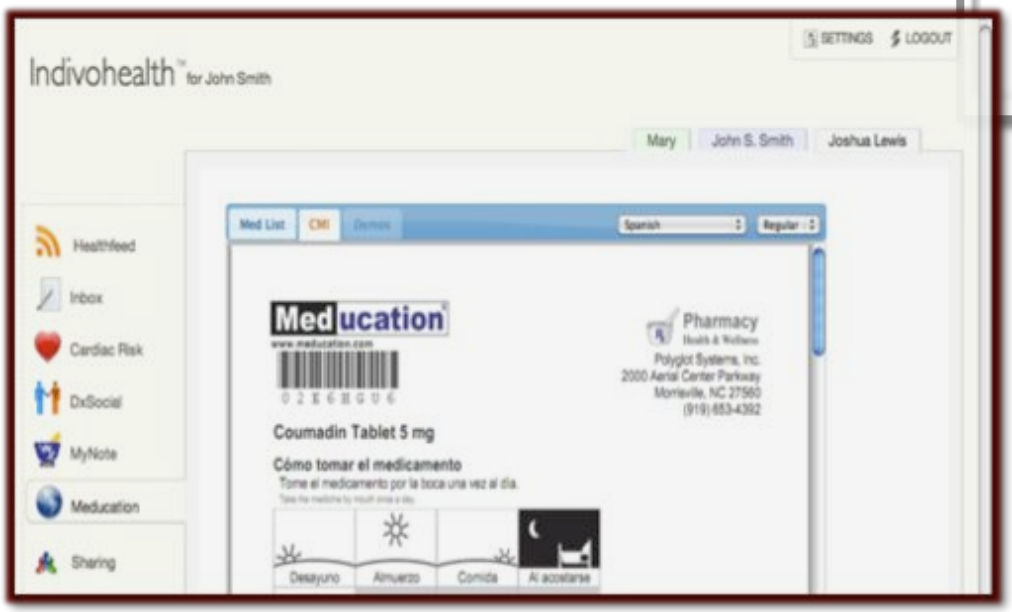
Posted by **Aneesh Chopra** on March 10, 2011 at 03:02 PM EDT

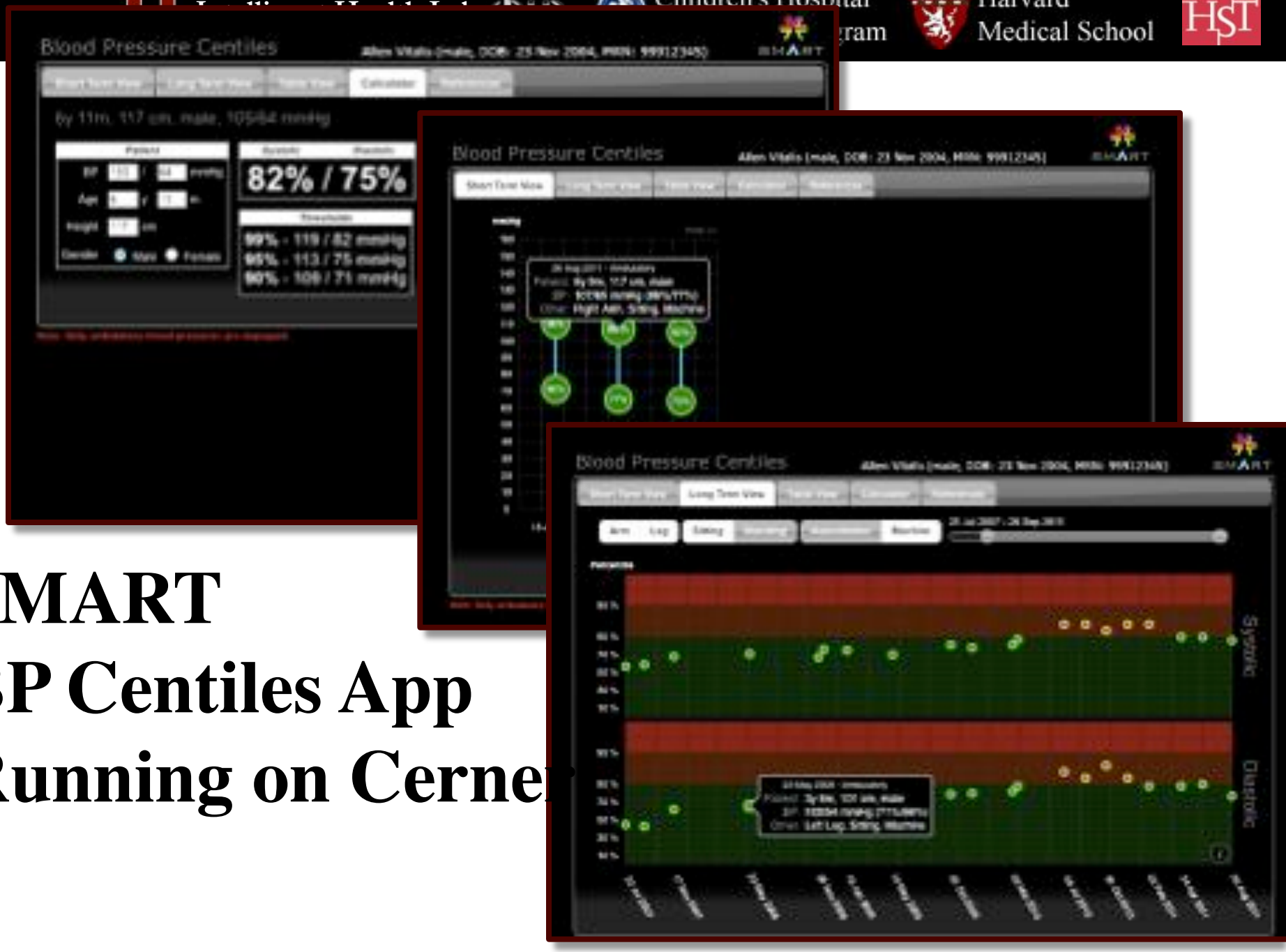
This week a research team at Children's Hospital of Boston and Harvard Medical School launched a prize to encourage innovative app developers to build new products and services that benefit patients and providers. The prize was created with funding from the Office of the National Coordinator for Health 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

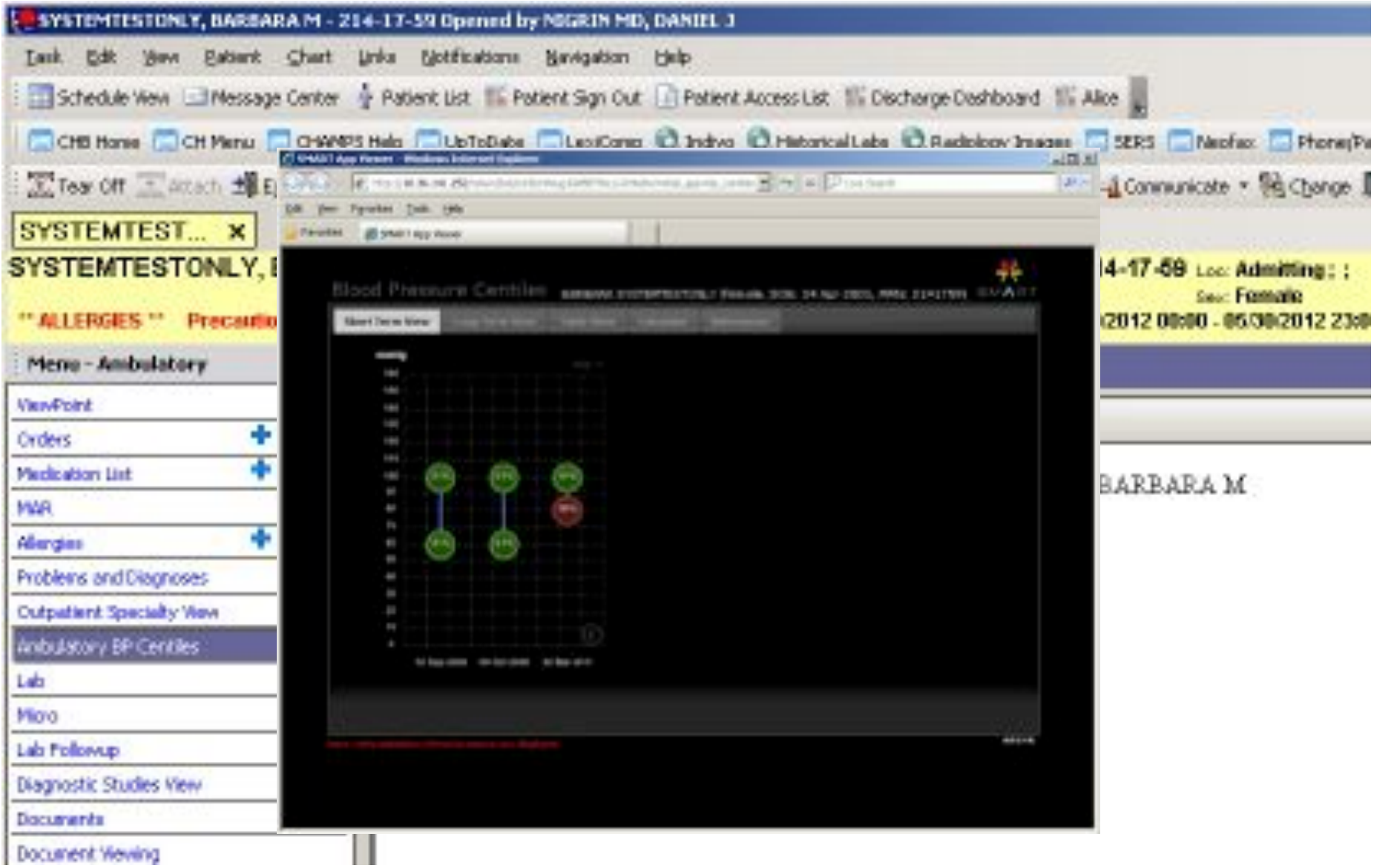

SMART
Alex Lewis
Meducation
Coumadin Tablet 5 mg
How to take medicine


Alex Lewis
Meducation
Coumadin Tablet 5 mg
Cómo tomar el medicamento


Indivohealth for John Smith
SETTINGS
LOGOUT
Mary
John S. Smith
Joshua Lewis
Healthfeed
Inbox
Cardiac Risk
DxSocial
MyNote
Meducation
Sharing
Meducation
Pharmacy
Coumadin Tablet 5 mg
Cómo tomar el medicamento
Tome el medicamento por la boca una vez al día.
Desayuno
Almuerzo
Comida
Al acostarse



SMART
BP Centiles App
Running on Cerner


SYSTEMTESTONLY, BARBARA M - 214-17-59 Opened by NGRIN MD, DANIEL J
Task Edit View Patient Chart Links Notifications Navigation Help
Schedule View
Message Center
Patient List
Patient Sign Out
Patient Access List
Discharge Dashboard
Allie
Tear Off
Communicate
Change
SYSTEMTEST...
SYSTEMTESTONLY,
** ALLERGIES **
Menu - Ambulatory
ViewPoint
Orders
Medication List
MAR
Allergies
Problems and Diagnoses
Outpatient Specialty View
Ambulatory BP Centiles
Lab
Micro
Lab Followup
Diagnostic Studies View
Documents
Document Viewing
Blood Pressure Centiles
4-17-59
Loc: Admitting: ;
Sex: Female
2012 00:00 - 05/30/2012 23:
BARBARA M

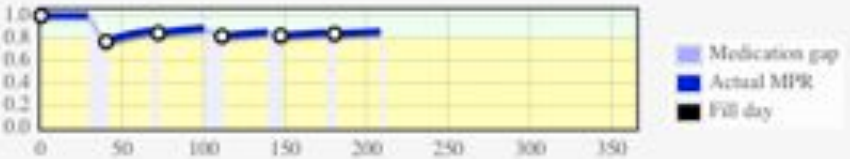
Medication adherence

Medication Possession Ratio Monitor

Home | About | Med details | All meds

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

Intake unique	Intake similar	Identical	Hospital similar	Hospital unique
Nitrostat PO daily 40 mg		Toprol-XL PO daily 25 mg		Folic acid PO daily 1 mg
Ripsix PO daily 75 mg		Enalapril PO BID 20 mg		
Tylenol PO PRN 325 mg		Amiodarone PO daily alt 200 mg		
		Aspirin PO daily 325 mg		
		Isosorbide dinitrat PO TID 30 mg		
		Amiodipine PO BID 2.5 mg		
	Lipitor PO daily 40 mg		Lipitor PO HS 80 mg	
	Nitrostat SL PRN 0.4 mg		Nitroglycerin SL PRN 0.4 mg	

Detail Nothing to display.

Patient: Jose Martinez

11/21/2011

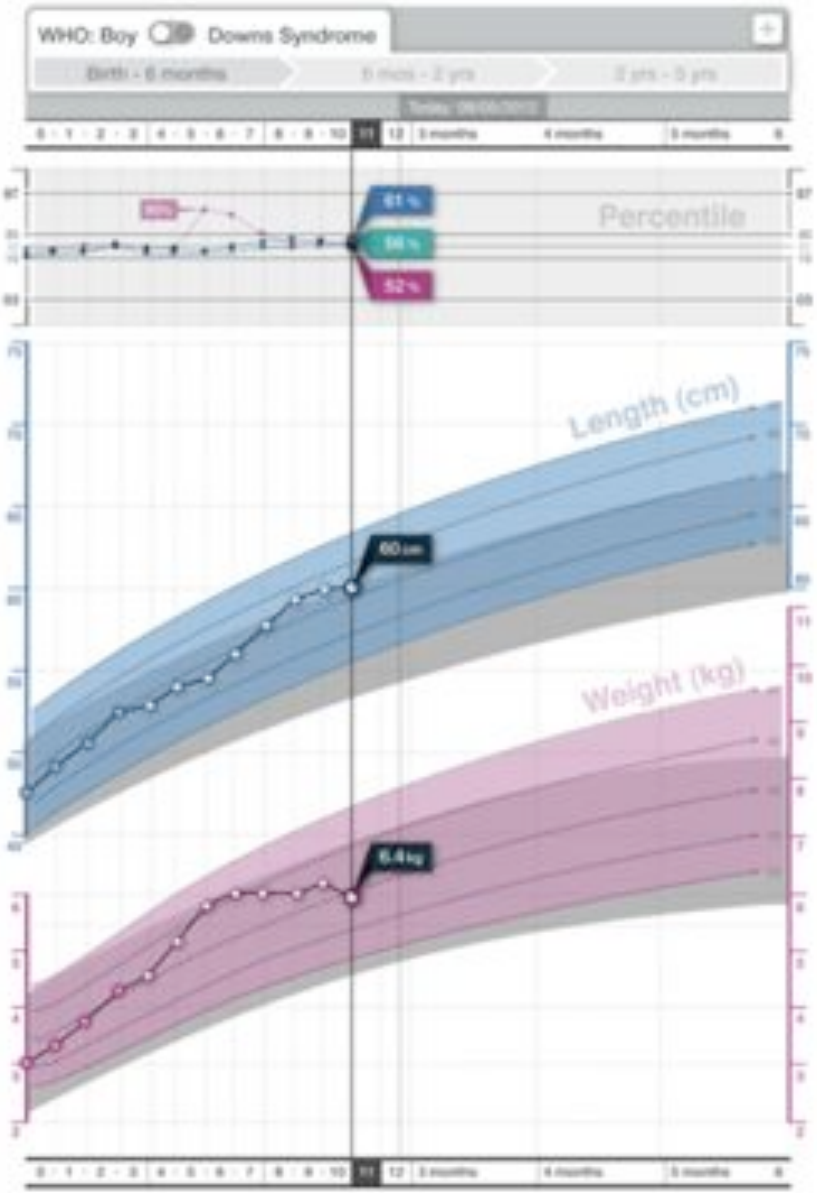
Medicines you need to take every day:

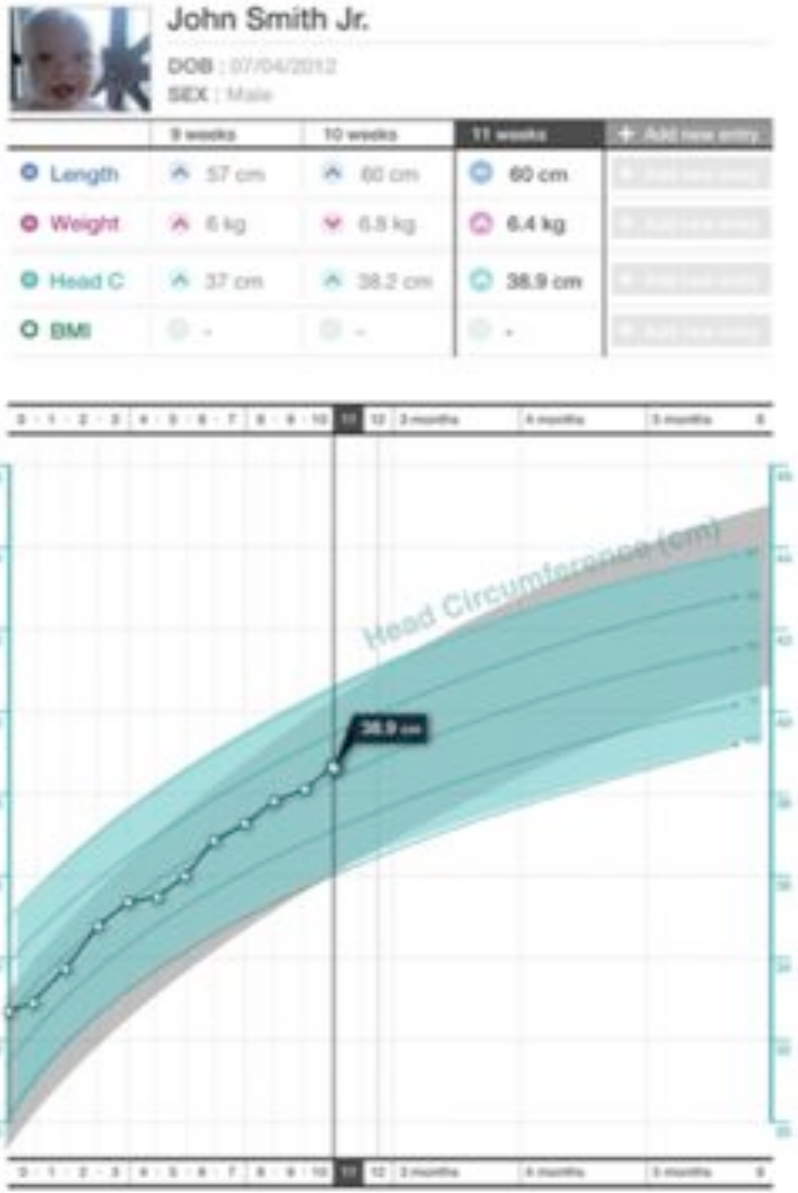
	Morning	Noon	Evening	Bedtime	
Diovan Tablet 160 mg	1				This medicine is used to treat high blood pressure.
Aspirin Tablet 81 mg	1				This medicine helps to reduce blood clots.
Actos Tablet 30 mg	1				This medicine is used to control blood sugar.
Lasix Tablet 40 mg	1/2		1/2		This medicine is used to help treat a weak heart.
Glucophage Tablet 1000 mg			1		This medicine is used to control blood sugar.
Lipitor Tablet 40 mg				1	This medicine is used to control cholesterol in the blood.
Advair Diskus 100/50 Inhaler	1 puff		1 puff		This medicine is used to treat asthma.
Potassium Chloride Powder 20 mEq/packet	1 packet				This medicine is used to replace potassium in the body.

Medicines you should take as needed:

Vicodin Tablet	Take the medicine by mouth every 6 hours. Take one (1) pill each time.	This medicine is used to relieve pain.

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).


WHO: Boy
Downs Syndrome
Percentile
Length (cm)
Weight (kg)
60 cm
6.4 kg

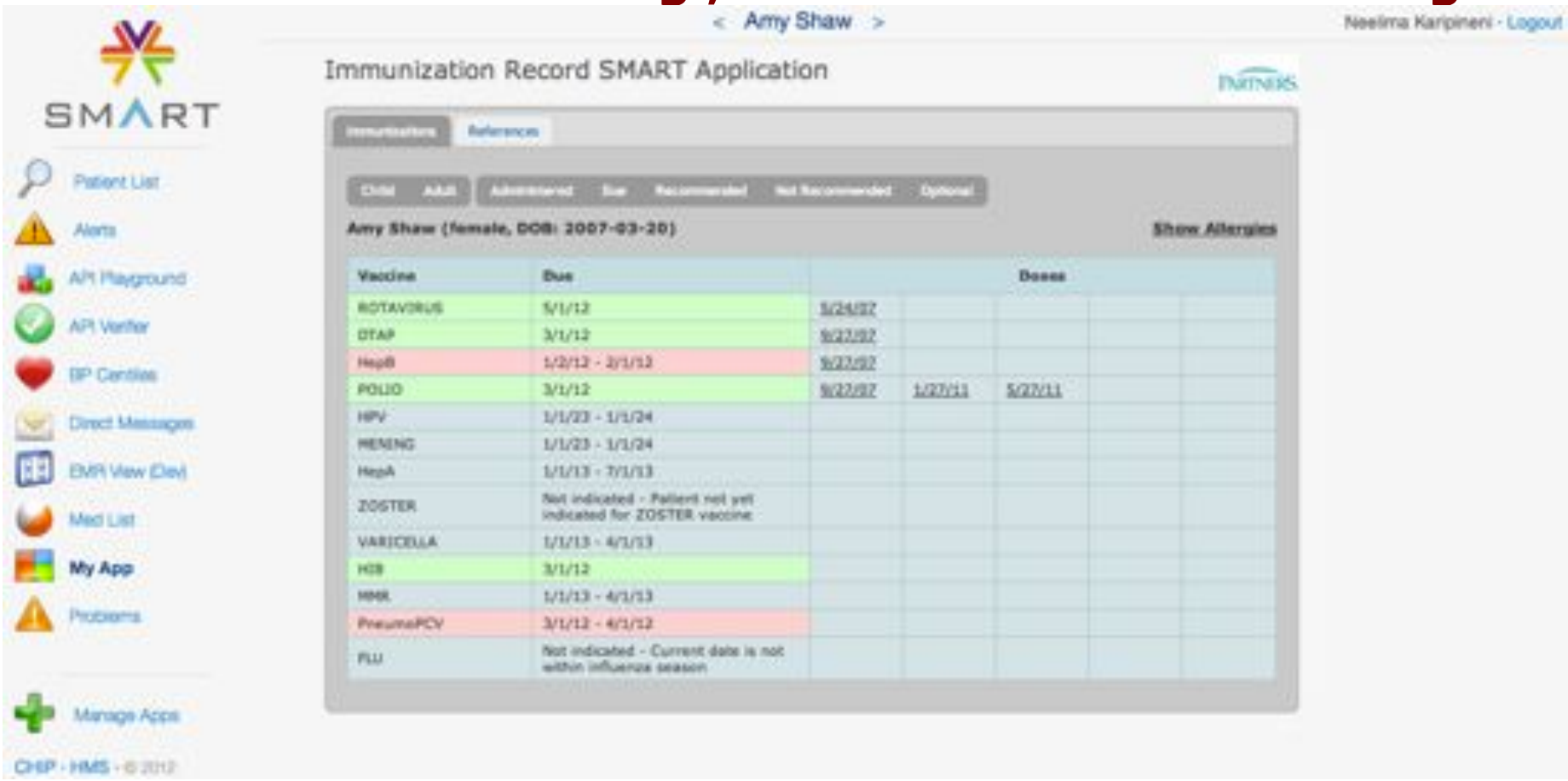

John Smith Jr.
DOB : 07/04/2012
SEX : Male
9 weeks
10 weeks
11 weeks
Length
57 cm
60 cm
60 cm
Weight
6 kg
6.5 kg
6.4 kg
Head C
37 cm
38.2 cm
38.9 cm
BMI
Head Circumference (cm)

BUILDING BLOCK APPS

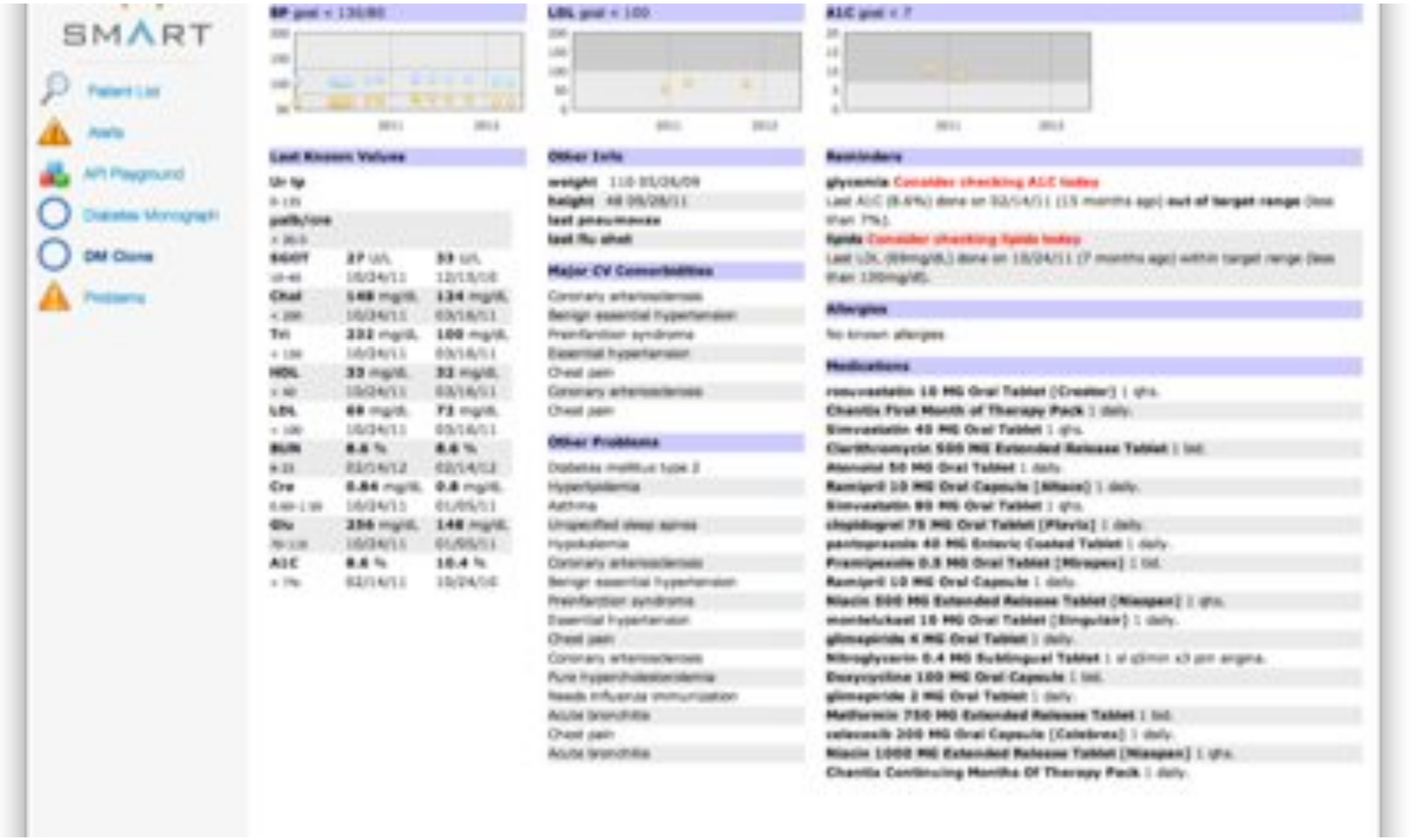
Mashups:
e.g., Genomic Medicine: There's an App for that

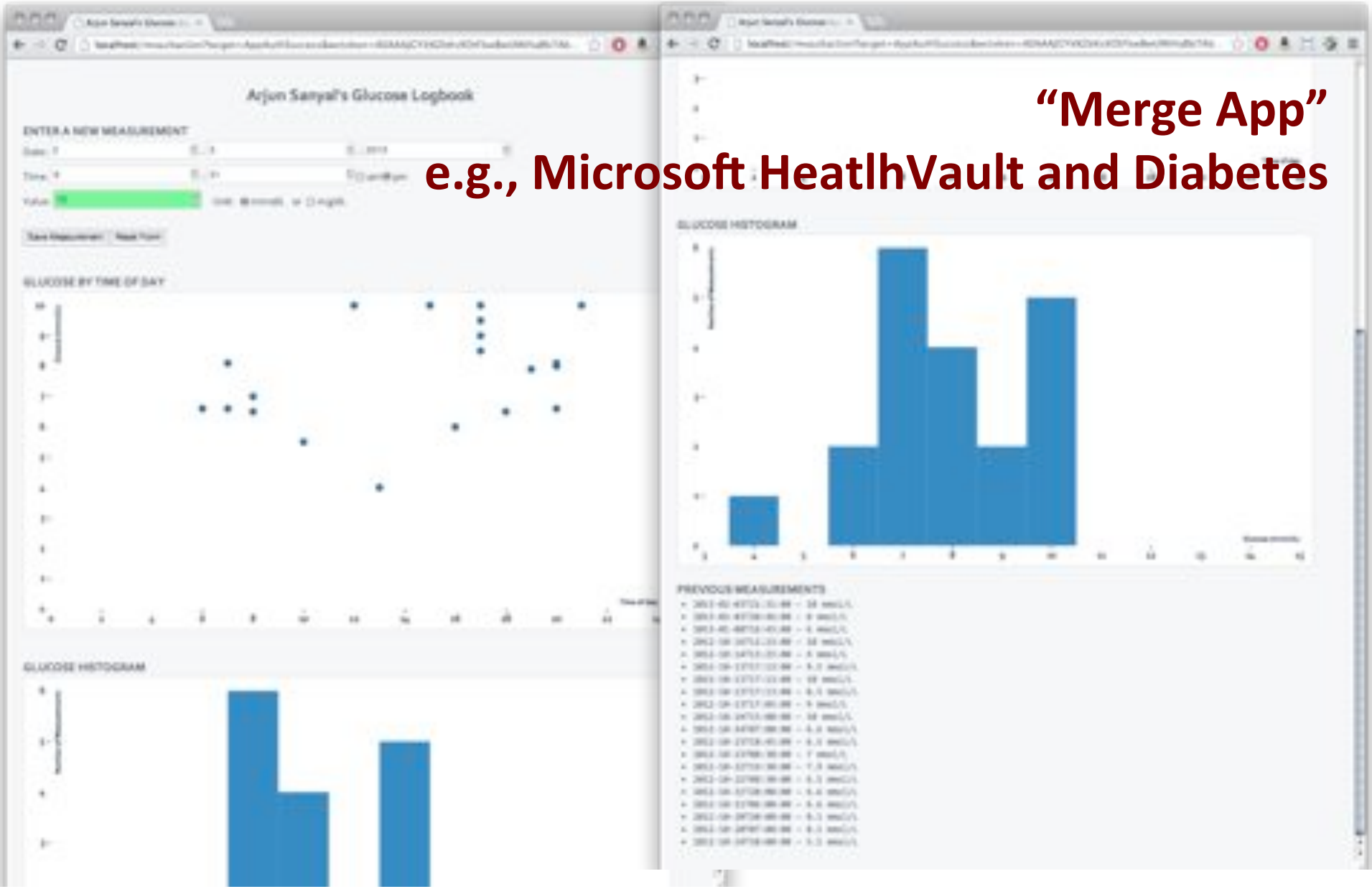
- Linkage to external decision support services
  - ✓ Pharmacogenomic rule sets
  - ✓ Decision support for doctors—associations

Decision Support Integration
e.g., Immunization Forecasting



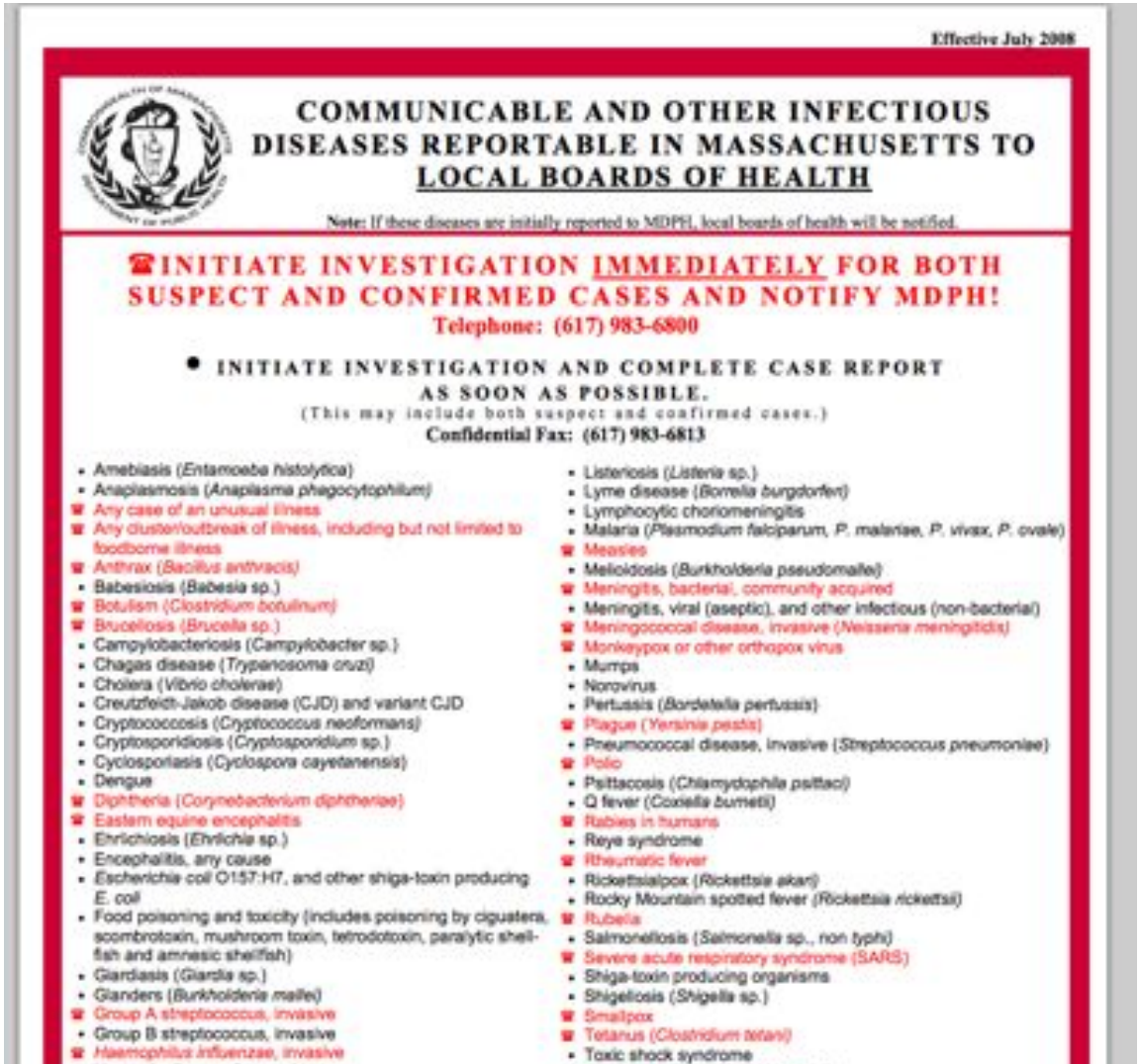
Monograph app e.g., Diabetes





"Merge App"
e.g., Microsoft HeatlhVault and Diabetes

Coming Soon-reporting—automated + manual



Effective July 2008

COMMUNICABLE AND OTHER INFECTIOUS DISEASES REPORTABLE IN MASSACHUSETTS TO LOCAL BOARDS OF HEALTH

Note: If these diseases are initially reported to MDPH, local boards of health will be notified.

☎ INITIATE INVESTIGATION IMMEDIATELY FOR BOTH SUSPECT AND CONFIRMED CASES AND NOTIFY MDPH!
Telephone: (617) 983-6800

- **INITIATE INVESTIGATION AND COMPLETE CASE REPORT AS SOON AS POSSIBLE.**
(This may include both suspect and confirmed cases.)
Confidential Fax: (617) 983-6813

- Amebiasis (*Entamoeba histolytica*)
- Anaplasmosis (*Anaplasma phagocytophilum*)
- ♛ Any case of an unusual illness
- ♛ Any cluster/outbreak of illness, including but not limited to foodborne illness
- ♛ Anthrax (*Bacillus anthracis*)
- Babesiosis (*Babesia* sp.)
- ♛ Botulism (*Clostridium botulinum*)
- ♛ Brucellosis (*Brucella* sp.)
- Campylobacteriosis (*Campylobacter* sp.)
- Chagas disease (*Trypanosoma cruzi*)
- Cholera (*Vibrio cholerae*)
- Creutzfeldt-Jakob disease (CJD) and variant CJD
- Cryptococcosis (*Cryptococcus neoformans*)
- Cryptosporidiosis (*Cryptosporidium* sp.)
- Cyclosporiasis (*Cyclospora cayetanensis*)
- Dengue
- ♛ Diphtheria (*Corynebacterium diphtheriae*)
- ♛ Eastern equine encephalitis
- Ehrlichiosis (*Ehrlichia* sp.)
- Encephalitis, any cause
- *Escherichia coli* O157:H7, and other shiga-toxin producing *E. coli*
- Food poisoning and toxicity (includes poisoning by ciguatera, scombrotoxin, mushroom toxin, tetrodotoxin, paralytic shellfish and amnesic shellfish)
- Giardiasis (*Giardia* sp.)
- Glanders (*Burkholderia mallei*)
- ♛ Group A streptococcus, invasive
- Group B streptococcus, invasive
- ♛ *Haemophilus influenzae*, invasive
- Listeriosis (*Listeria* sp.)
- Lyme disease (*Borrelia burgdorferi*)
- Lymphocytic choriomeningitis
- Malaria (*Plasmodium falciparum, P. malariae, P. vivax, P. ovale*)
- ♛ Measles
- Melioidosis (*Burkholderia pseudomallei*)
- ♛ Meningitis, bacterial, community acquired
- Meningitis, viral (aseptic), and other infectious (non-bacterial)
- ♛ Meningococcal disease, invasive (*Neisseria meningitidis*)
- ♛ Monkeypox or other orthopox virus
- Mumps
- Norovirus
- Pertussis (*Bordetella pertussis*)
- ♛ Plague (*Yersinia pestis*)
- Pneumococcal disease, invasive (*Streptococcus pneumoniae*)
- ♛ Polio
- Psittacosis (*Chlamydophila psittaci*)
- Q fever (*Coxiella burnetii*)
- ♛ Rabies in humans
- Reye syndrome
- ♛ Rheumatic fever
- Rickettsialpox (*Rickettsia akari*)
- Rocky Mountain spotted fever (*Rickettsia rickettsii*)
- ♛ Rubella
- Salmonellosis (*Salmonella* sp., non *typhi*)
- ♛ Severe acute respiratory syndrome (SARS)
- Shiga-toxin producing organisms
- Shigellosis (*Shigella* sp.)
- ♛ Smallpox
- ♛ Tetanus (*Clostridium tetani*)
- Toxic shock syndrome

Collaborators and Implementers

- EMR Vendors: Cerner, Allscripts, Siemens, VA World Vist, OpenMRS, Microsoft
- Major payors
- Pharma
- Major tech companies


North Pacific Ocean
North Atlantic Ocean
South Pacific
South Atlantic
Russia
Mongolia
China
South Korea
Japan
Thailand
Indonesia
Papua New Guinea
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Mexico
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Colombia
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Peru
Bolivia
Chile
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Spain
Algeria
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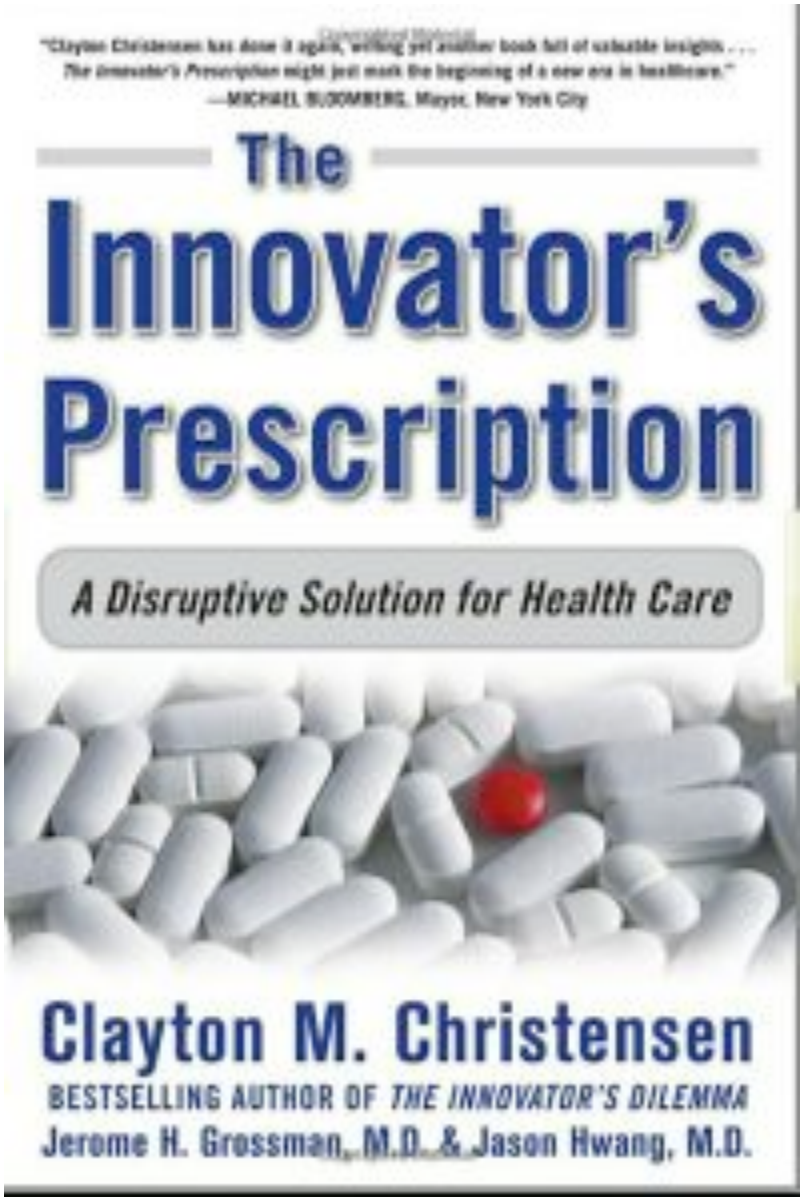
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Will disruptive innovation be fostered in healthcare

Diffusion Strategy

- 1. EHR Integration
- 2. "Side car" Strategy
- 3. Meaningful Use 2 and data liquidity

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