

Addressing the ‘Consumability’ Challenge in Healthcare: Role of Informatics and Analytics

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Outline

- Role of information and informatics
- Consumability challenge with data and technologies
- Illustrative example – data visualization for decision support
- Summary and conclusions

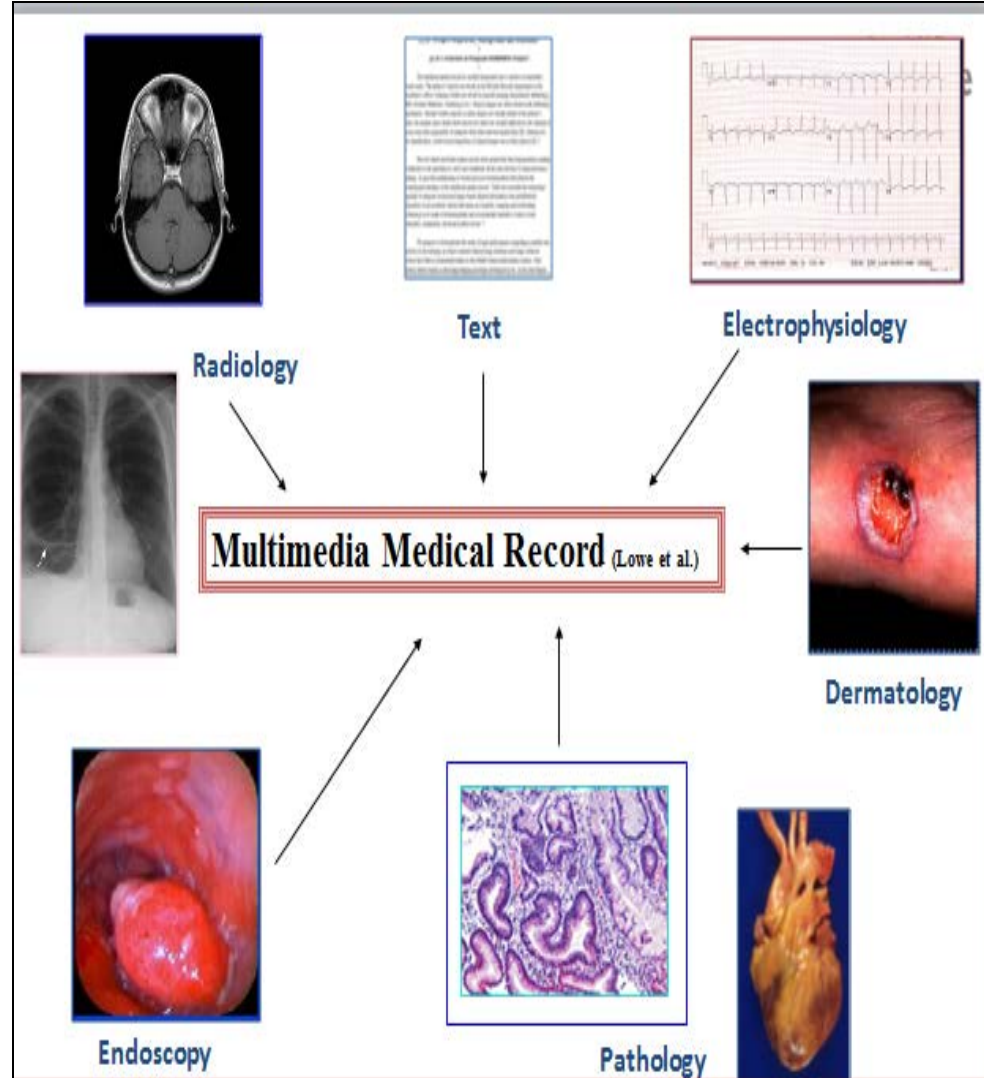
What is Healthcare Informatics?

- Computer applications in healthcare delivery, management, and administration
- Study, invention, and computer implementation of tools and methodologies to enhance quality of patient care and control costs by
 1. improving communication, understanding and management of health information
 2. applying data and knowledge in the healthcare decision-making process, and
 3. creating seamlessly integrated healthcare service and delivery systems

Current Technologies

- Electronic Health Records (EHR)
- Computerized Provider Order Entry Systems (CPOE)
- Electronic Prescribing (e-Rx)
- Personal Health Records (PHR)
- Decision Support Systems (DSS)
- Mobile health
-

Electronic Health Records (EHRs) Carnegie Mellon Heinz College



Personal Health Records (PHRs)

What is HealthVault?

Microsoft HealthVault is a trusted place for people to gather, store, use, and share health information online. [Learn more](#)

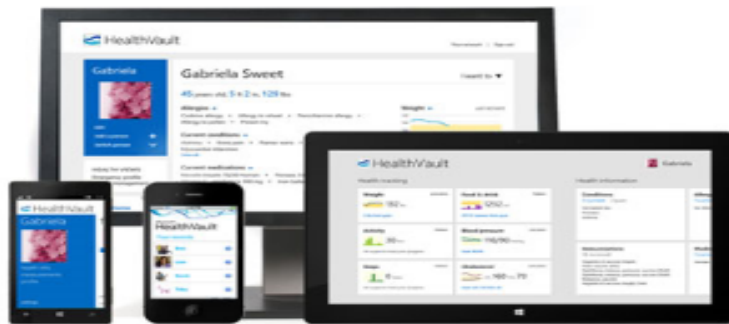
Organize your family's health information.

Achieve your fitness goals.

Be better prepared for doctor visits and unexpected emergencies.

Create a more complete picture of your health, with you at the center.

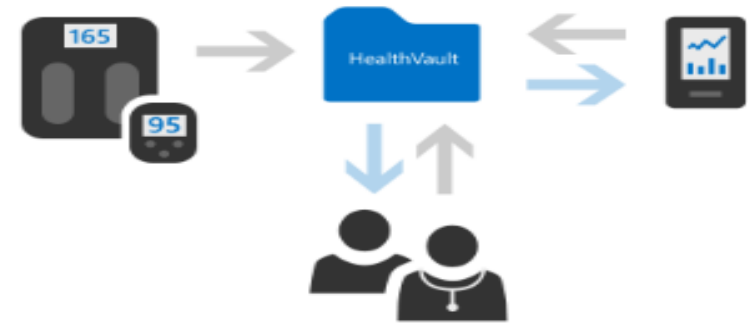
Connect anywhere



Connect from the [web](#), [Windows](#), [Windows Phone](#), [iPhone](#), and more.

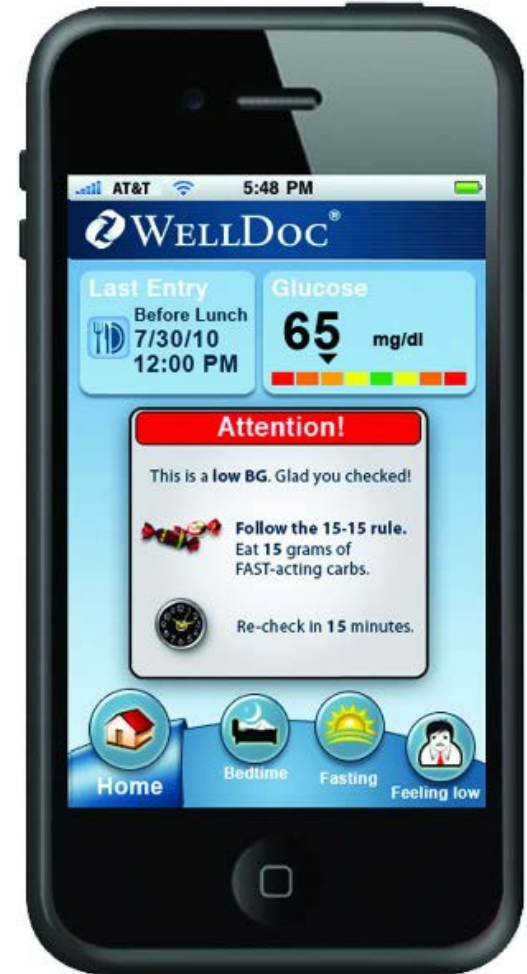
<https://www.healthvault.com/us/en>

Connect your health data



Learn [how HealthVault works](#) with connected apps and devices and helps you share information with people you trust.

Mobile Health Applications



<http://www.elinext.com/images/articles/mob-apps-healthcare-ind-thumb.jpg>

Information – The Emerging Capital of Healthcare

Healthcare today is so **complex that it has surpassed the** human mind's capacity to operate without aid. The greatest challenge is to take the appropriate information and apply it to **individual patients at the time when** the information is needed

Human Information Processing Capacity

Available Patient Information

Healthcare Informatics

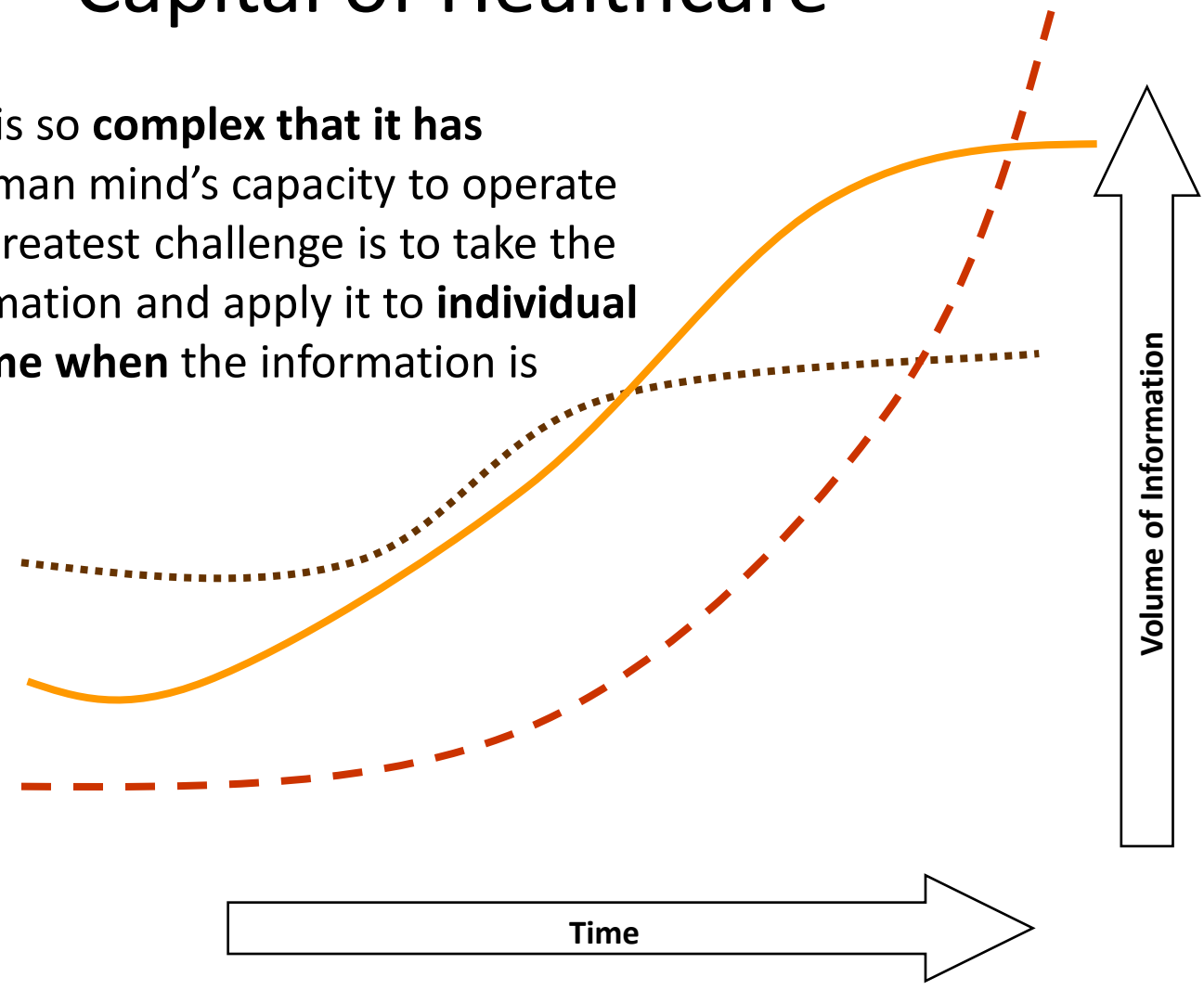


Figure: Diamond Cluster International, Inc.

“Consumability” Challenge in Healthcare

- ▶ EHRs provide an significant level of access to clinical information
- ▶ Healthcare environments are rich in **data** but lacking in the **analytics** that can provide cognitively guided, real time decision support
- ▶ “Usability absent from ‘adolescent’ EHRs”
 - “Many certified EHRs are neither user-friendly nor designed to meet HITECH’s ambitious goals of improving quality and efficiency in the healthcare system,” Dr. David Blumenthal, NEJM 2009

(Former national coordinator for health information technology)

Why is it important?

- Challenges with adoption and diffusion
- Unanticipated adverse consequences of information technology
- Impacts on patient satisfaction, clinical outcomes, patient safety and organizational effectiveness

Example: Data Visualization for Chronic Disease Risk Assessment

- **“Consuming” Data - Chronic Disease Risk Assessment**
 - Critical, but difficult task for primary care practices
 - A multidimensional, multi-level information processing task
 - Time constrained clinicians unable to provide recommended care

R. Padman, D. Neill, C. Harle, A. Joshi, 2011;
C. Harle, D. Neill, R. Padman, 2008, 2012

Context: Diabetes Management

- Diabetes affects 25.8 million people (8.3% of the U.S. population), 18.8 million diagnosed and 7.0 million undiagnosed
- It is the leading cause of kidney failure, non-traumatic lower-limb amputations, and new cases of blindness among adults in the United States
- It is a major cause of heart disease and stroke
- It is the seventh leading cause of death in the United States

National Diabetes Fact Sheet, 2011

Diabetes Complications

- **“Heart disease and stroke**
 - In 2004, heart disease was noted on 68% of diabetes-related death certificates among people aged 65 years or older
 - In 2004, stroke was noted on 16% of diabetes-related death certificates among people aged 65 years or older
 - Adults with diabetes have heart disease death rates about 2 to 4 times higher than adults without diabetes
 - The risk for stroke is 2 to 4 times higher among people with diabetes”

National Diabetes Fact Sheet, 2011

Research Question

How can methods for shared decision making be developed to improve the complex information processing task of chronic disease risk assessment and communication in a patient-centered healthcare delivery environment?

Solution: Synthesize, summarize, contextualize, and visualize data for 'informed consumption'

C. Harle, D. Neill, R. Padman, 2008, 2012

Data Visualization for Health Risk Assessment

- Assess patients' disease risk at the *population, individual and intervention levels*

Solution:

- Integrate statistical dimensionality reduction methods with information visualization
- Contextualize the access, exploration and comparison of risk predictions

Dviz: Data Visualization Tool

- DViz is a broadly applicable data visualization tool to help assess disease risk and explore related interventions that may be most appropriate for a patient
- This tool is currently designed to help clinicians quickly, easily and visually understand their patients with diabetes

C. Harle, D. Neill, R. Padman, *INFORMS DM-HI 2008, IEEE 2012*

DViz: Risk Factors and Target Goals

The statistical model uses a set of variables, shown below, to calculate heart disease risk and visualize patient data.

Gender	BMI
Systolic BP	HbA1c
Diastolic BP	MI History
LDL	Anti Lipid
HDL	Anti Hypertensive
Family CVD	Anti Hyperglycemic
Smoker	Albuminuria
Aspirin Daily	Regular Exam
Exercise	Bypass
Ethnic Risk	Angina
Age	Heart Faliure

Target goals for critical variables are set as shown below.

- Systolic BP : less than 140
- Diastolic BP : less than 90
- LDL : less than 100
- HDL : greater than 40
- HbA1c : less than 7

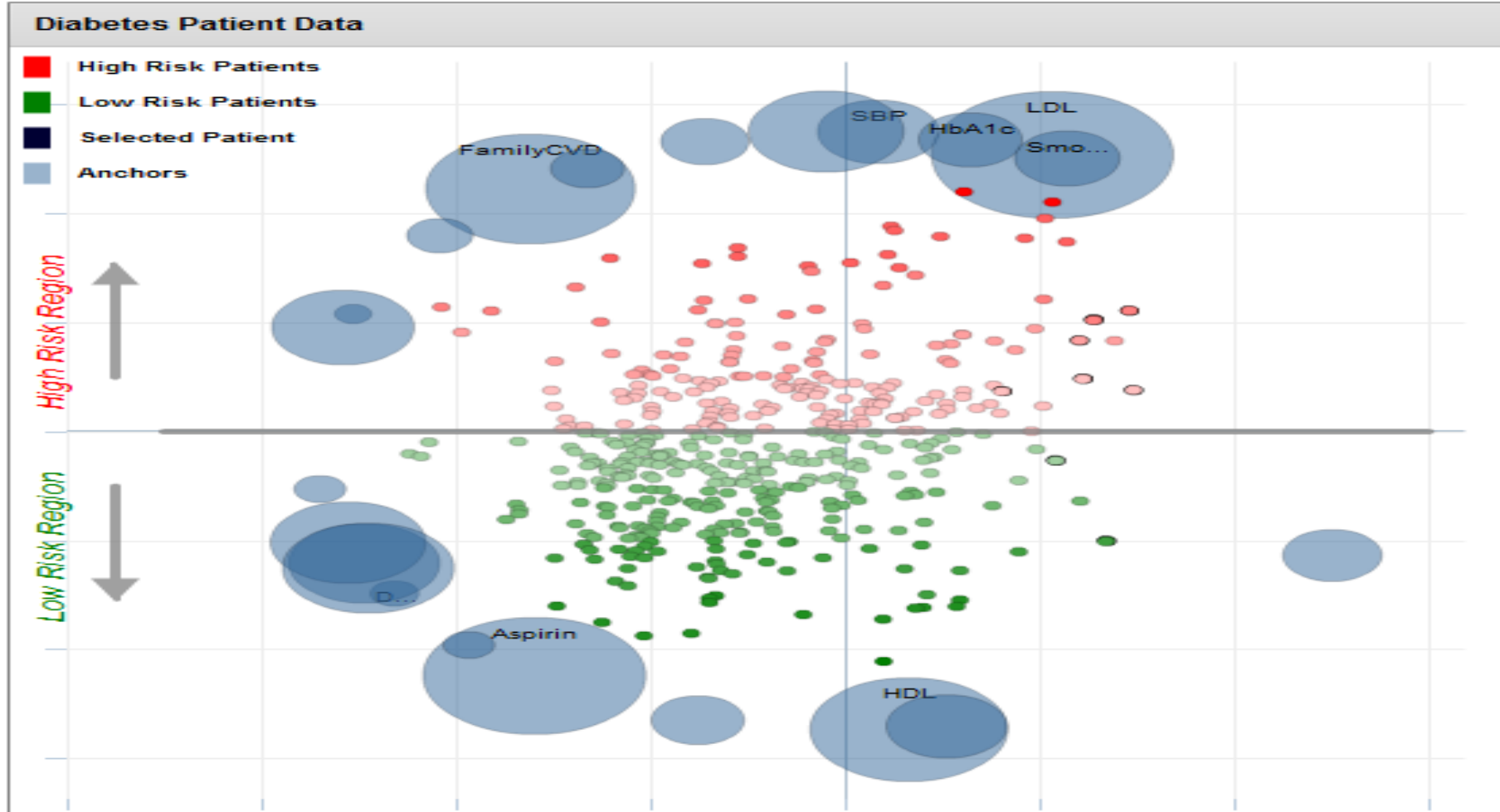
Patient ID

Assess Risk of Heart Attack for Patients with Diabetes

Status Quo-Population View: Diabetes data

ID	Gender	Age	SBP	DBP	LDL	H
298	Female	60	200	110	200	
285	Female	60	200	110	200	
295	Female	60	200	110	200	
306	Male	59	125	85	125	
305	Male	59	120	80	125	
161	Male	56	160	90	140	
287	Male	49	160	100	140	
324	Female	47	180	96	164	
244	Male	48	150	90	200	
225	Female	50	140	89	137	
170	Male	59	128	80	180	
192	Female	50	140	90	150	
563	Male	54	155	90	122	
489	Male	57	160	72	118	
564	Female	36	137	86	226.4	

New Approach - Population View



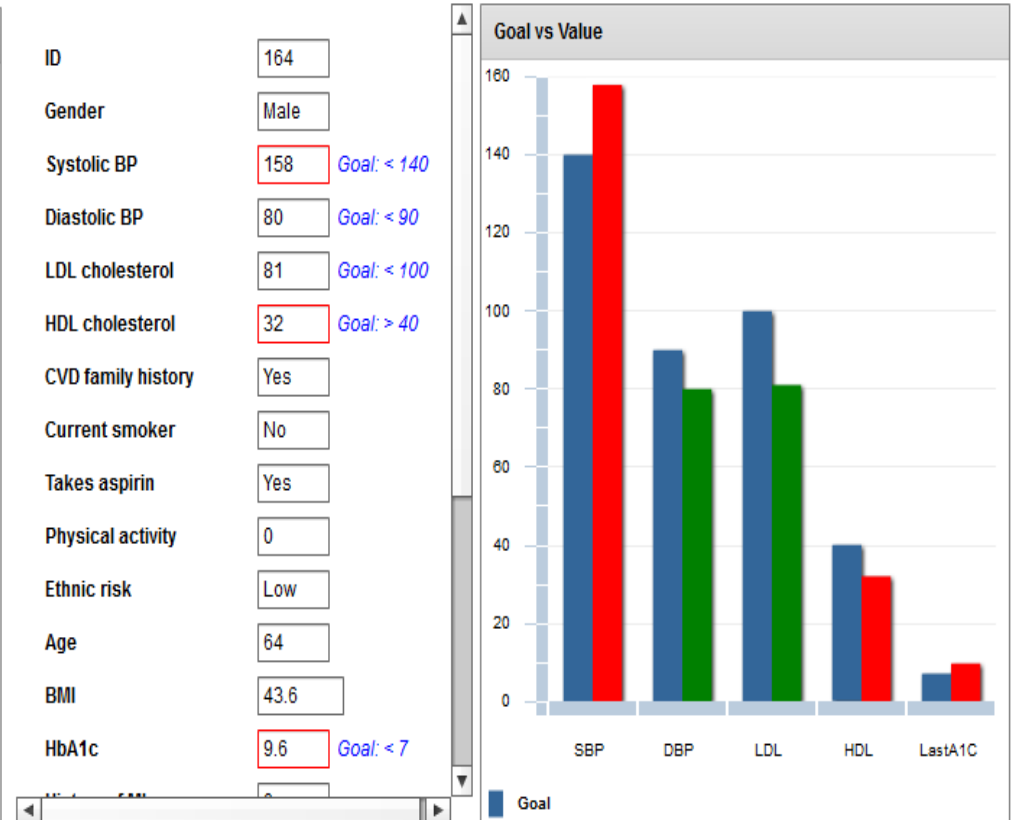
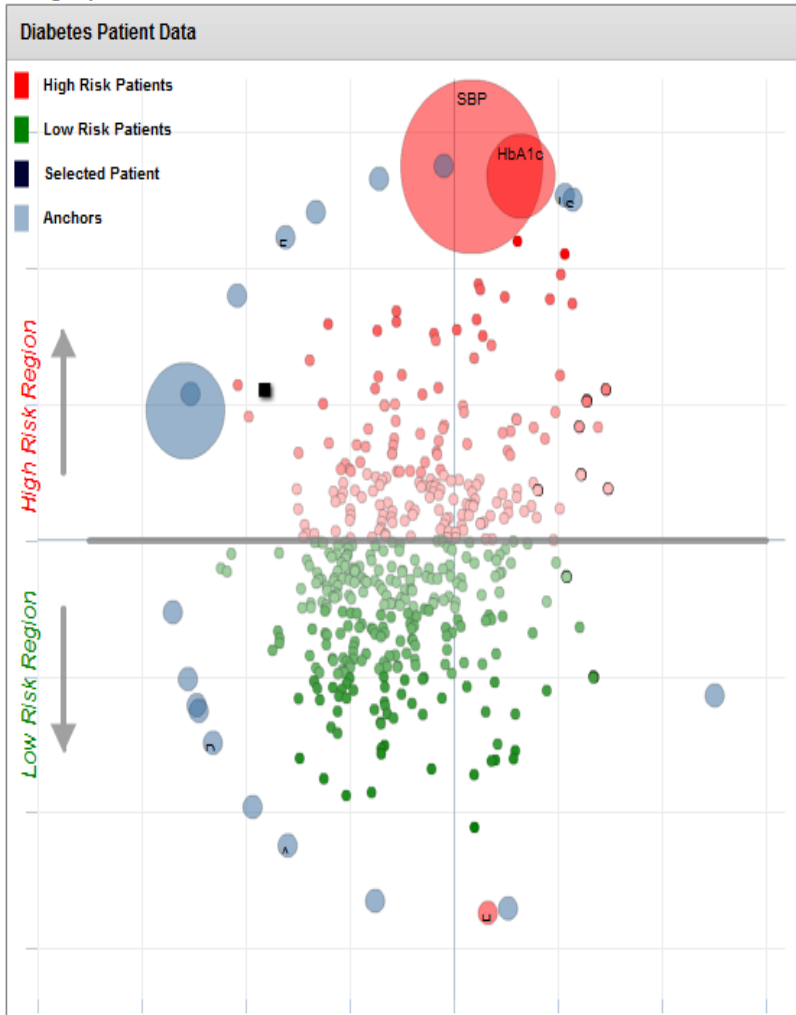
The overview graph uses an attraction metaphor : patients with high values for a given risk factor, such as LDL, relative to other patients in the population, are pulled closer to that risk factor, while patients with low values are pushed away. The size of each risk factor, shown as a circle on the graph, represents its strength of attraction.

New Approach - Patient View

Dviz Patient View

To change the value of the variables and visually see how the selected patient's risk changes please click "Intervention"

When clicking on an individual patient, the risk factors visually change size to reflect their impact on that particular patient's risk rather than their effects on the population as a whole.



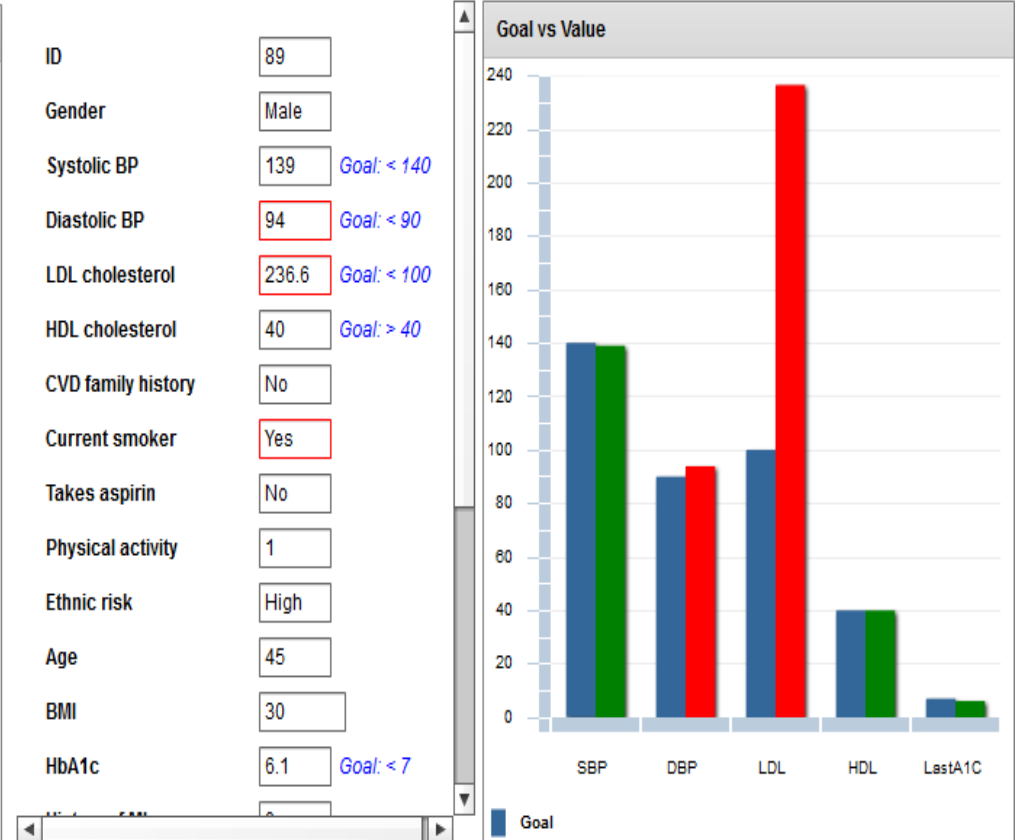
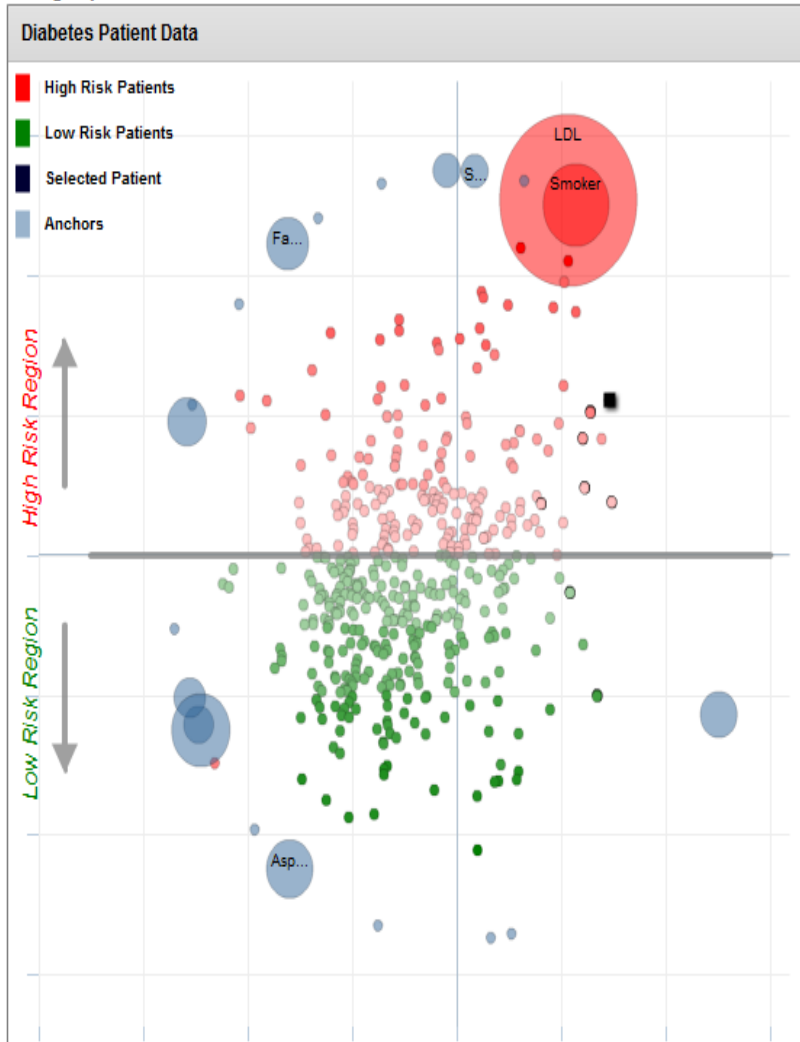
Patient ID

New Approach - Patient View

Dviz Patient View

To change the value of the variables and visually see how the selected patient's risk changes please click "Intervention"

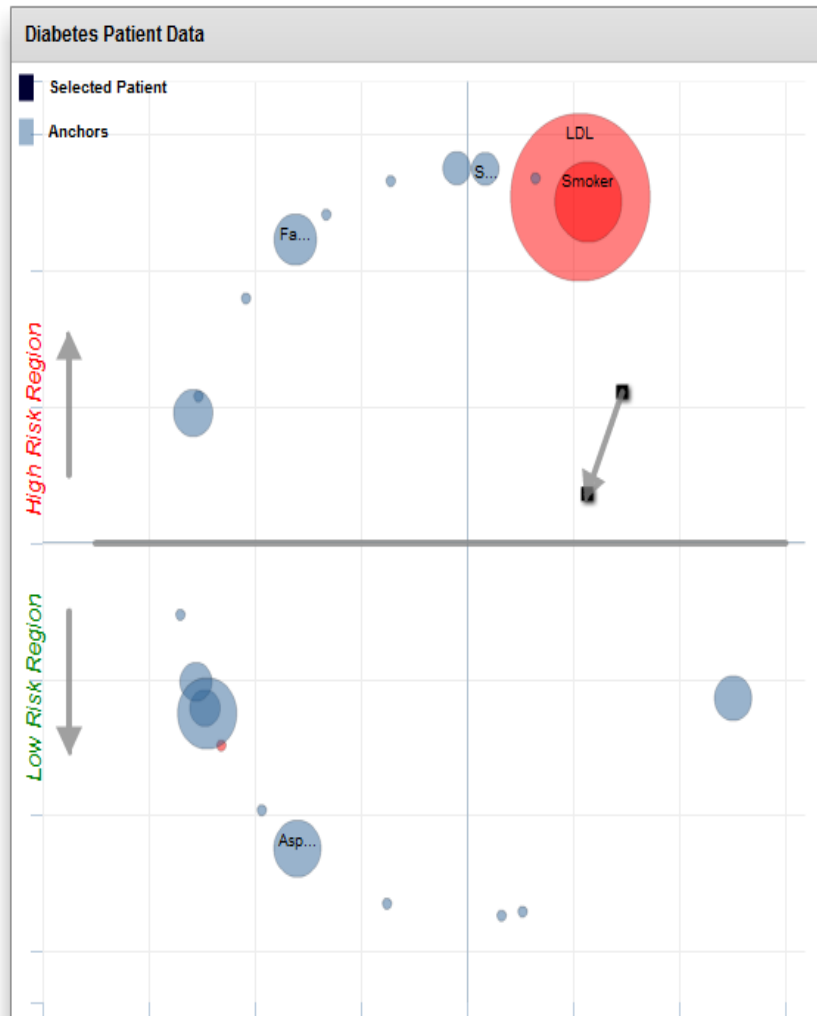
When clicking on an individual patient, the risk factors visually change size to reflect their impact on that particular patient's risk rather than their effects on the population as a whole.



Patient ID

New approach - Intervention View

Change the target values of the selected patient and click "Calculate" to see how the patient's risk changes



	Current Values	Target Values
ID	<input type="text" value="89"/>	<input type="text"/>
Gender	<input type="text" value="Male"/>	<input type="text" value="Male"/>
Systolic BP	<input type="text" value="139"/> Goal: < 140	<input type="text" value="139"/>
Diastolic BP	<input type="text" value="94"/> Goal: < 90	<input type="text" value="94"/>
LDL cholesterol	<input type="text" value="236.6"/> Goal: < 100	<input type="text" value="100"/>
HDL cholesterol	<input type="text" value="40"/> Goal: > 40	<input type="text" value="40"/>
CVD family history	<input type="text" value="No"/>	<input type="text" value="No"/>
Current smoker	<input type="text" value="Yes"/>	<input type="text" value="Yes"/>
Takes aspirin	<input type="text" value="No"/>	<input type="text" value="No"/>
Physical activity	<input type="text" value="1"/>	<input type="text" value="1"/>
Ethnic risk	<input type="text" value="High"/>	<input type="text" value="High"/>
Age	<input type="text" value="45"/>	<input type="text" value="45"/>
BMI	<input type="text" value="30"/>	<input type="text" value="30"/>
HbA1c	<input type="text" value="6.1"/> Goal: < 7	<input type="text" value="6.1"/>

Patient ID

Summary

- Dviz complements existing medical record information by providing both population level and individual level risk information in a visual and interactive format
- Information can be accessed quickly and shared with patients to potentially improve communication, education and outcomes – *provide link in a PHR?*
- It may improve risk analysis for time-constrained practitioners with large, at-risk patient populations – *provide link in an EHR?*

Conclusions

- Health care data is being generated at societal scale, captured and linked
 - From EHRs, decision support systems, mobile and social media usage, RFID tags....
- Need analytics support to design for consumability of data, services and applications that
 - Provide cognitively guided information delivery at point of use
 - Integrate large scale data analysis with behavioral science to pioneer new techniques and applications
 - Accommodate privacy, confidentiality and security requirements

Thank you!