



Health Informatics on FHIR

Module 3 Overview

Mark L Braunstein, MD
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Health Informatics on FHIR

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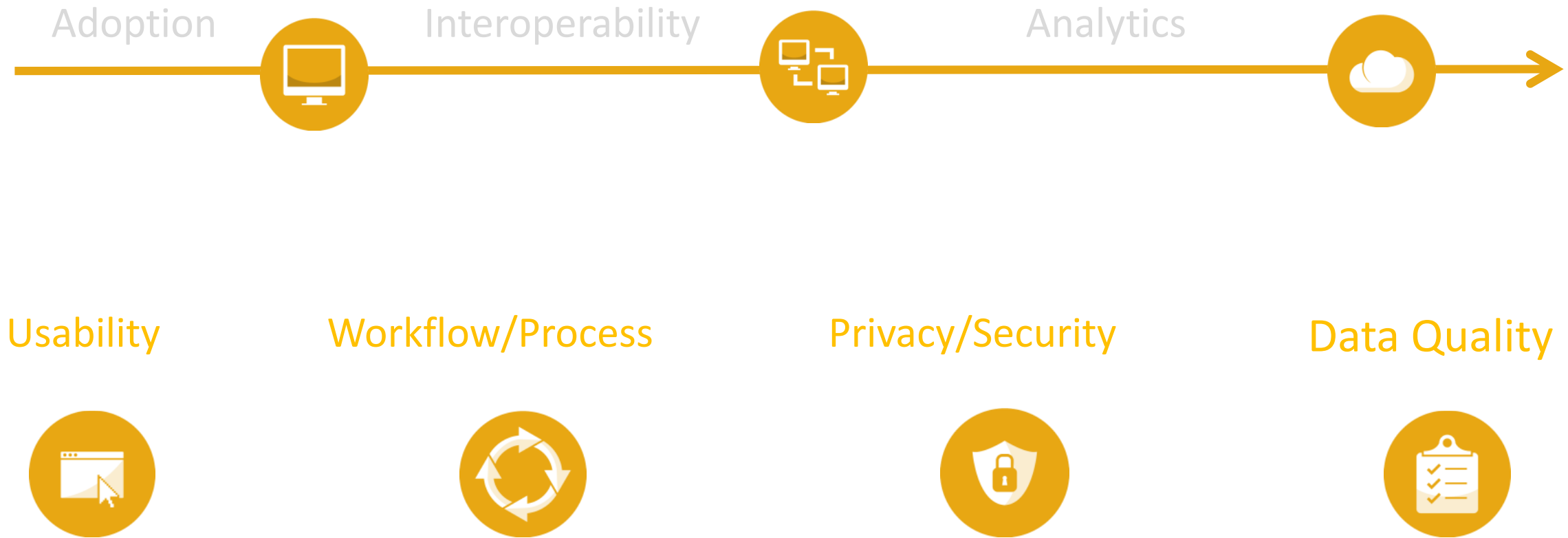
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Real World Applications & Challenges

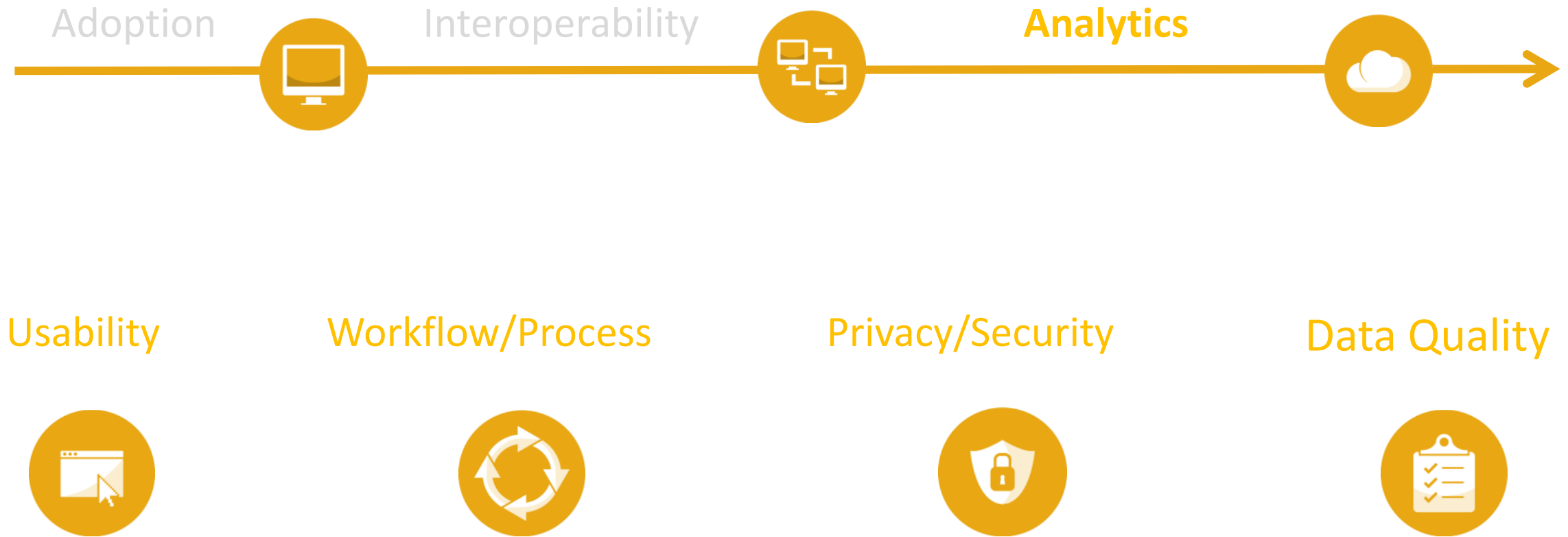
Module Objectives

- Become familiar with some key real world applications of health informatics
- Understand design challenges and potential solutions
- Become familiar with a few analytics-based health informatics tools

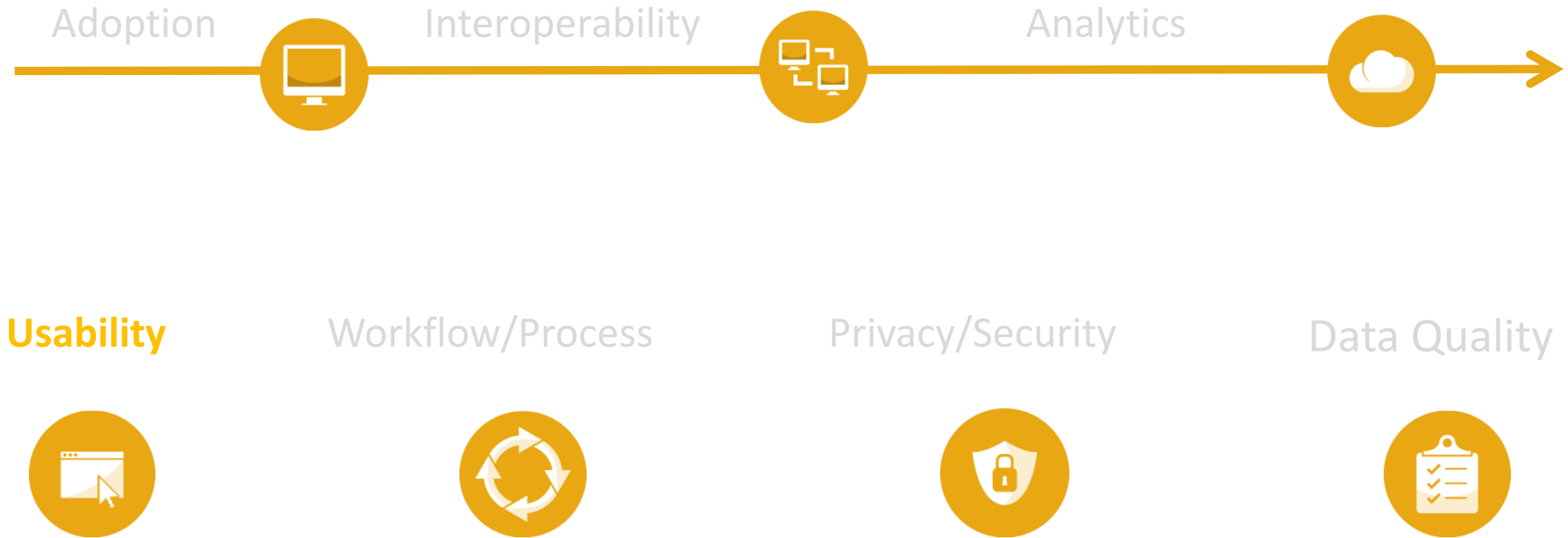
Implementing IOM's Vision: "Secondary" Challenges



Implementing IOM's Vision: "Secondary" Challenges



Implementing IOM's Vision: "Secondary" Challenges





Health Informatics on FHIR

Real World Applications & Challenges: Usability

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Health Informatics on FHIR

Real World Applications & Challenges: Usability

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Usability: Patient Safety


“Health care in the United States is not as safe as it should be--and can be. At least 44,000 people, and perhaps as many as 98,000 people, die in hospitals each year as a result of **medical errors that could have been prevented**”

Usability: Patient Safety

“Poor EHR system design and improper use can cause **EHR-related errors** that jeopardize the integrity of the information in the EHR, leading to errors that endanger patient safety or decrease the quality of care.”

Usability: EHR-related Errors

Troponin: a highly specific marker for **myocardial infarction** or *heart muscle cell death*



	07Jan11 11:00	07Jan11 16:30	07Jan11 23:32	08Jan11 06:59
Chemistry				
Chemistry				
Glucose Blood	106			110
BUN	16			14
Creatinine Blood	1.00			0.85
Sodium Blood	134			135
Potassium Blood	5.2			4.3
Chloride Blood	101			104
CO2	23			21
Calcium Blood	9.3			9.2
Protein Total Serum	7.2			6.6
Albumin Blood	3.9			3.6
AST	39			29
ALT	30			25
Alkaline Phosphatase	65			58
Bilirubin Total	0.6			0.7
BUN/Creat Ratio	16			16
AGAP	15			14
GFR AFR AM (CALC)	>60			>60
GFR NON AFR AM (CALC)	>60			>60
CKMB with Reflex		3.1		2.6
Troponin I Quantitative	0.04	0.05	0.05	0.05
Beta Natriuretic Peptide	187			
TSH 3rd Generation	1.45			
Cholesterol Blood				154
Triglycerides Blood				226

Usability: EHR-related Errors

“one-third of patients clinically diagnosed as having **pulmonary embolism** presented with elevated serum troponin I concentrations”

J Am Coll Cardiol. 2000 Nov 1;36(5):1632-6

D-dimer: a non-specific marker for pulmonary embolus

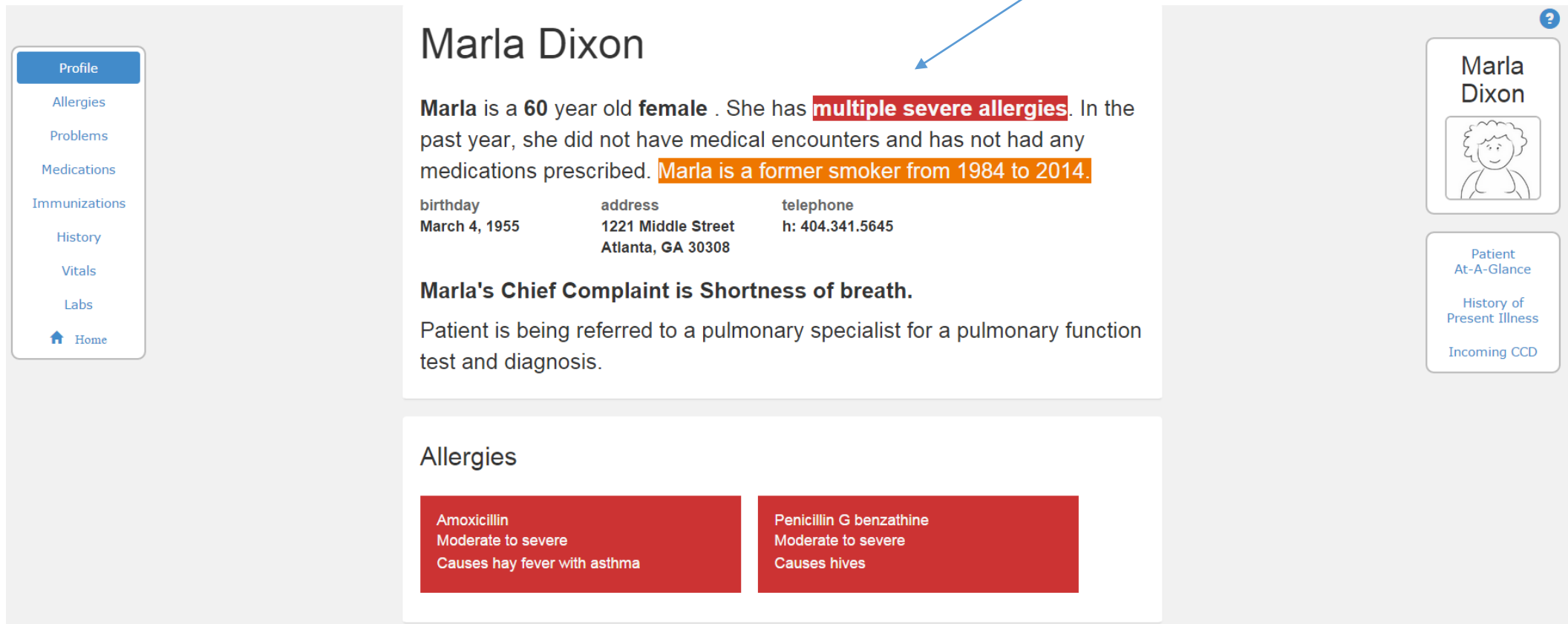
Not all results are being shown. Multiple result categories - Performed from 07-Jan-2011 to 08-Jan-2011

	07Jan11 11:00	07Jan11 16:30	07Jan11 23:32	08Jan11 06:59
Triglycerides Blood				226
HDL Cholesterol				47
LDL Cholesterol				62
-Non HDL Cholesterol				107
Hematology				
Coagulation Studies				
Partial Thromboplastin Time	27.0		30.6	70.5
D-Dimer	1240			1237
PT Seconds	13.5			
INR	0.96			
General Hematology				
WBC Result	11.5			8.2
RBC	3.94			3.85
Hemoglobin (Hb)	13.8			13.4
Hematocrit	39.1			38.6
MCV	99.2			100.2
MCH	35.0			34.7
MCHC	35.3			34.6
RDW	13.0			13.5
MPV	8.5			9.3
Platelet Count Result	282			258
Neutrophils	64			56
Lymphocytes	19			30
Monocytes	15			13
Eosinophils	1			2
Basophils	0			0

Page 2

Usability: Analytics Based Solution – Highlight the Important

Why is this hard?



Marla Dixon

Marla is a 60 year old female . She has **multiple severe allergies**. In the past year, she did not have medical encounters and has not had any medications prescribed. **Marla is a former smoker from 1984 to 2014.**

birthday	address	telephone
March 4, 1955	1221 Middle Street Atlanta, GA 30308	h: 404.341.5645

Marla's Chief Complaint is Shortness of breath.

Patient is being referred to a pulmonary specialist for a pulmonary function test and diagnosis.

Allergies

Amoxicillin Moderate to severe Causes hay fever with asthma	Penicillin G benzathine Moderate to severe Causes hives
---	---

Marla Dixon

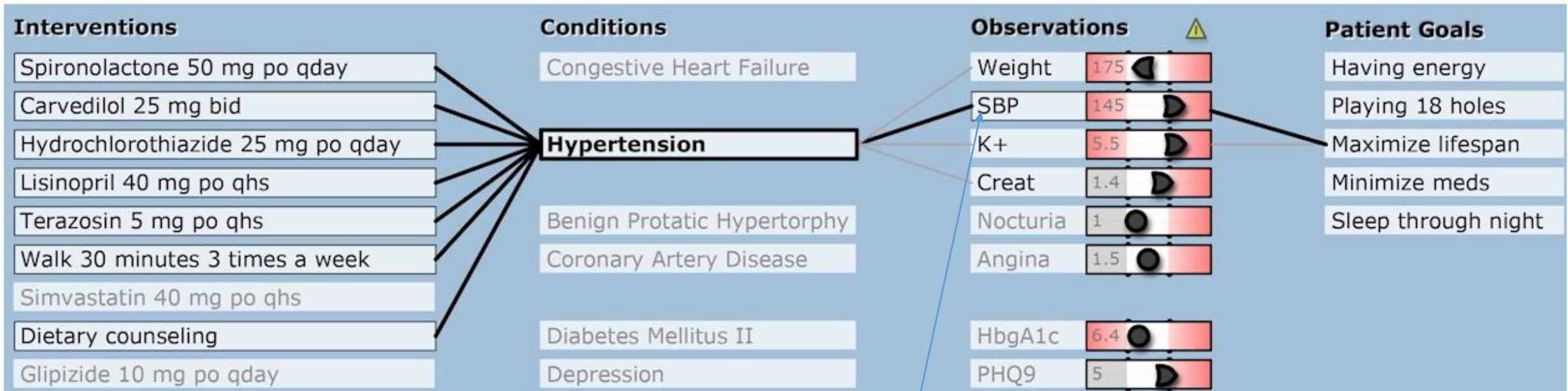
Patient At-A-Glance

History of Present Illness

Incoming CCD

Real World Applications and Challenges:

EHRs Typically Ignorant of Clinical Relationships



How is hypertension related to systolic blood pressure?

Real World Applications and Challenges:

Standards Can Help in Some Cases

Elevated

Parents

>

- Disorder of cardiovascular system (disorder)

- Hypertensive disorder, systemic arterial (disorder) ☆
 - SCTID: 38341003
 - Hypertensive disorder, systemic arterial (disorder)
 - BP - High blood pressure
 - BP+ - Hypertension
 - HBP - High blood pressure
 - HT - Hypertension
 - HTN - Hypertension
 - High blood pressure
 - High blood pressure disorder
 - Hypertension
 - Hypertensive disorder
 - Hypertensive disorder, systemic arterial
 - Hypertensive vascular degeneration
 - Hypertensive vascular disease
 - Systemic arterial hypertension

Has definitional manifestation → Finding of increased blood pressure

Finding site → Systemic circulatory system structure

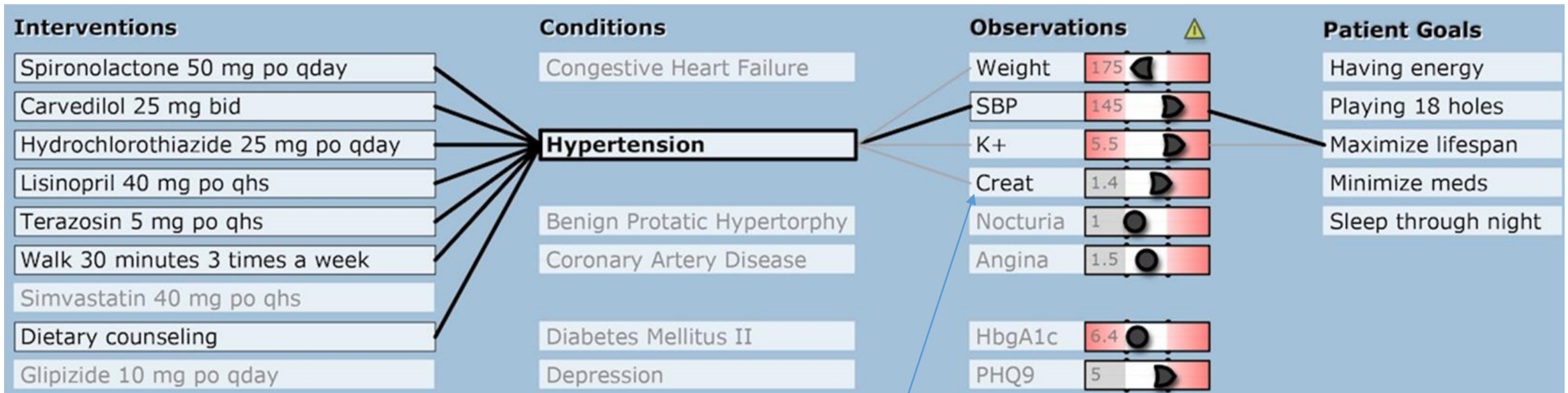
Children (21)

>

- Benign hypertension (disorder)
- Diastolic hypertension (disorder)
- Eclampsia added to pre-existing hypertension (disorder)
- Essential hypertension (disorder)
- Exertional hypertension (disorder)
- Hypertension complicating pregnancy, childbirth and the puerperium (disorder)
- Hypertension in chronic kidney disease due to type 1 diabetes mellitus (disorder)
 - Hypertension in chronic kidney disease due to type 2 diabetes mellitus (disorder)
 - Hypertension in the obstetric context (disorder)
 - Hypertension with albuminuria (disorder)
 - Hypertensive crisis (disorder)
 - Hypertensive episode (disorder)

Real World Applications and Challenges:

EHRs Typically Ignorant of Clinical Relationships



How is hypertension related to serum creatinine?

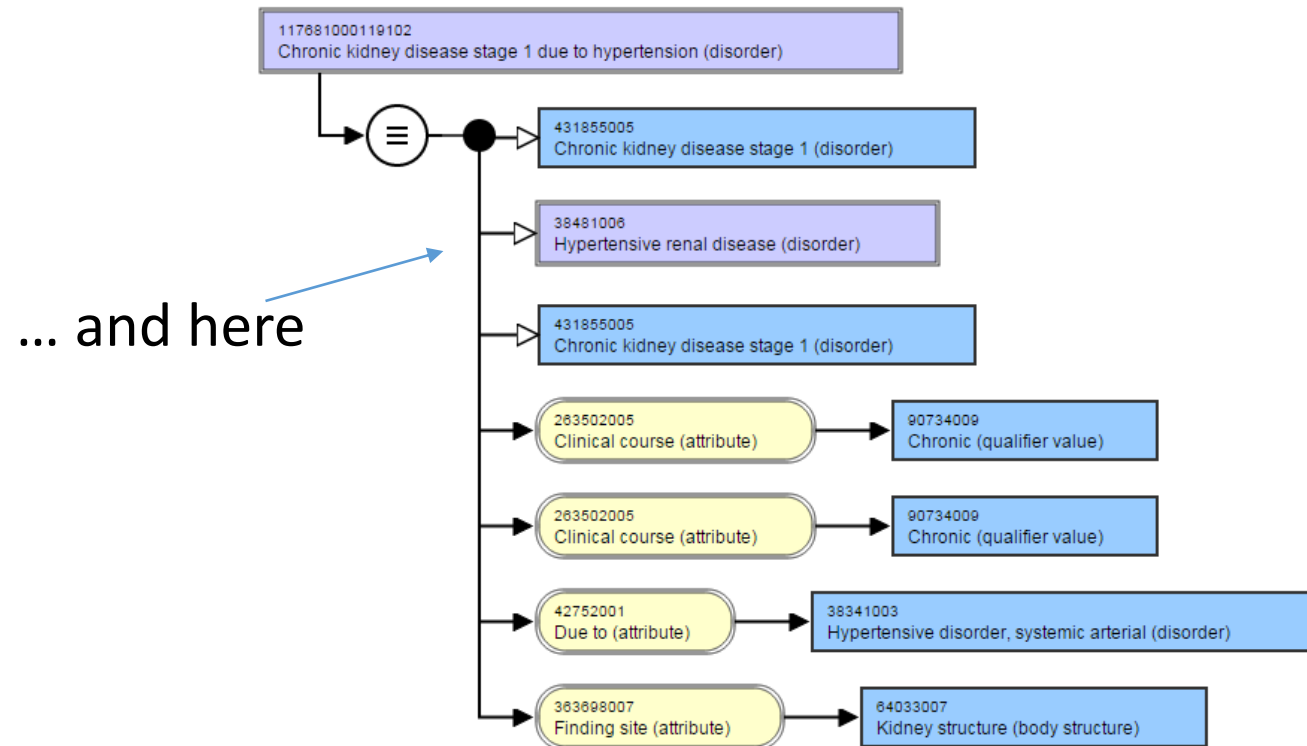
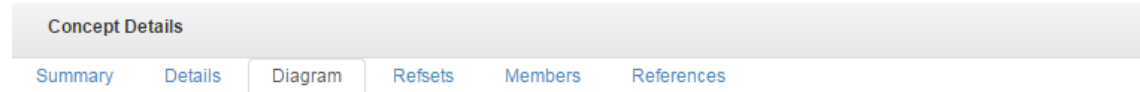
Real World Applications and Challenges:

Standards (SNOMED-CT) Can Help

Concept Details		🕒 ⚙️
Summary Details Diagram Refsets Members References		
▼ Associated finding (attribute) (5)		
Term	ConceptId	
⬢ Elevated blood pressure reading without diagnosis of hypertension (situation)	371622005	
⬢ Family history: Hypertension (situation)	160357008	
⬢ History of hypertension (situation)	161501007	
⬢ No family history: Hypertension (situation)	160273004	
⬢ Suspected hypertension (situation)	417312002	
➤ Associated with (attribute) (75)		
▼ Due to (attribute) (9)		
Term	ConceptId	
⬢ Cardiomegaly - hypertensive (disorder)	275516004	
⬢ 🇺🇸 Chronic kidney disease stage 1 due to hypertension (disorder)	117681000119102	
⬢ 🇺🇸 Chronic kidney disease stage 2 due to hypertension (disorder)	129181000119109	
⬢ 🇺🇸 Chronic kidney disease stage 3 due to hypertension (disorder)	129171000119106	
⬢ 🇺🇸 Chronic kidney disease stage 4 due to hypertension (disorder)	129151000119102	
⬢ 🇺🇸 Chronic kidney disease stage 5 due to hypertension (disorder)	129161000119100	
⬢ End stage renal disease on dialysis due to hypertension (disorder)	153891000119101	
⬢ Hypertensive leg ulcer (disorder)	238795008	
⬢ Ulcer of skin caused by ischemia due to hypertensive disease (disorder)	95343001	

But only
partially in this
case ...

Real World Applications and Challenges: Standards (SNOMED-CT) Can Help



Real World Applications and Challenges: LOINC

68996-8

Laboratory - end stage renal disease form 2728

PANEL HIERARCHY

LOINC#	LOINC Name	R/O/C	Cardinality	Ex. UCUM Units
68996-8	Laboratory - end stage renal disease form 2728			
1751-7	Albumin [Mass/volume] in Serum or Plasma	O		g/dL
49049-0	Collection time of Unspecified specimen	C		{clock_time}
68900-0	Albumin Lab Method	O		
2160-0	Creatinine [Mass/volume] in Serum or Plasma	R		mg/dL
718-7	Hemoglobin [Mass/volume] in Blood	O		g/dL
4548-4	Hemoglobin A1c/Hemoglobin.total in Blood	O		%
2093-3	Cholesterol [Mass/volume] in Serum or Plasma	O		mg/dL
13457-7	Cholesterol in LDL [Mass/volume] in Serum or Plasma by calculation	O		mg/dL
2085-9	Cholesterol in HDL [Mass/volume] in Serum or Plasma	O		mg/dL
2571-8	Triglyceride [Mass/volume] in Serum or Plasma	O		mg/dL

Real World Applications and Challenges: FHIR Value Sets

Path	Definition	Type	Reference
Condition.code Condition.relatedItem.code	Identification of the Condition or diagnosis.	Example	http://hl7.org/fhir/vs/condition-code
Condition.category	A category assigned to the condition. E.g. finding Condition diagnosis concern condition	Incomplete	http://hl7.org/fhir/vs/condition-category
Condition.status	The clinical status of the Condition or diagnosis	Fixed	http://hl7.org/fhir/condition-status
Condition.certainty	The degree of confidence that this condition is correct	Example	http://hl7.org/fhir/vs/condition-certainty
Condition.severity	A subjective assessment of the severity of the condition as evaluated by the clinician.	Example	http://hl7.org/fhir/vs/condition-severity
Condition.relatedItem.type	The type of relationship between a condition and its related item	Fixed	http://hl7.org/fhir/condition-relationship-type

due-to

this condition follows the identified condition/procedure/substance and is a consequence of it.



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Real World Applications & Challenges: Efficiency

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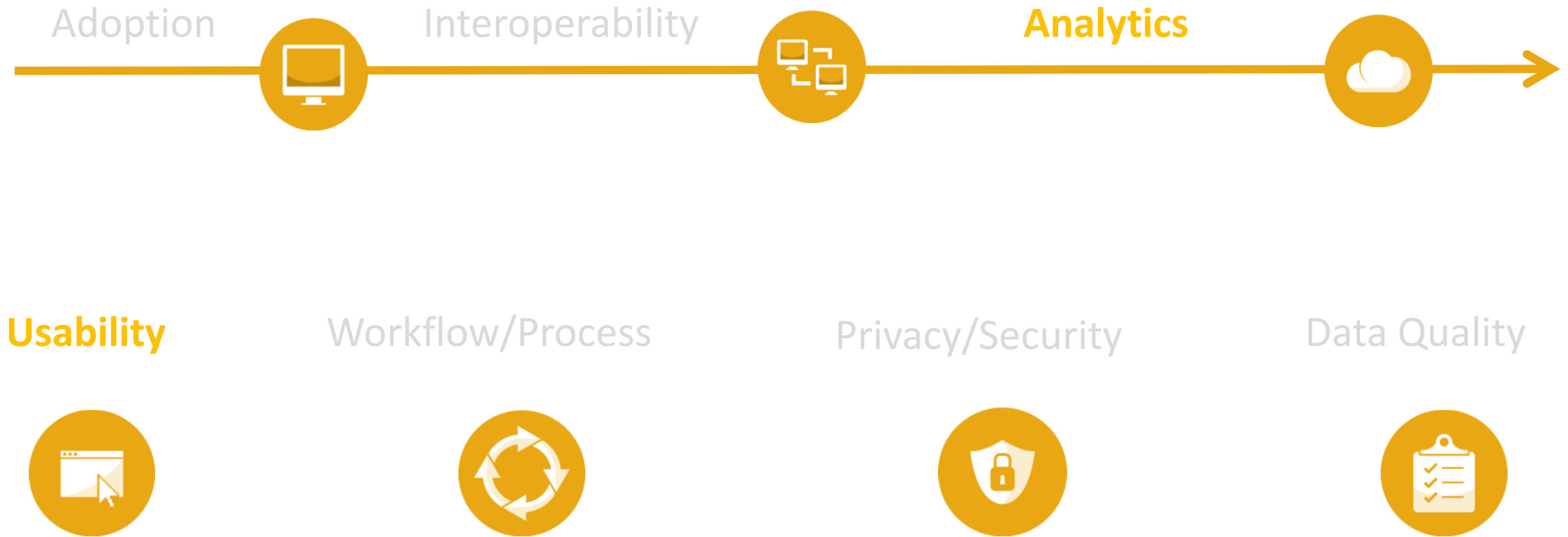
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Real World Applications & Challenges: Efficiency

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Usability versus Complexity: Balance



Physician Attitudes to Date: Mixed

Positives:

In our practice, our electronic health record improves the quality of care 61%

Using an electronic health record enhances patient-doctor communication that is not face to-face 54%

Negatives:

When I am providing clinical care, our electronic health record slows me down 43%

Our electronic health record requires me to perform tasks that other staff could perform 61%

Our electronic health record improves my job satisfaction 38%

Using an electronic health record interferes with patient-doctor communication during ... clinical care 36%

I receive an overwhelming number of electronic messages in this practice 31%

Overall:

Based on my experience to date, I prefer using paper medical records instead of electronic records 18%

Real World Applications and Challenges

Positive- Improved Care

In our practice, our electronic health record improves the quality of care 61%

I think [the EHR is] fantastic. ... **A real EHR, one that actually gives you things in fields that are usable and useful, makes all the difference.** I can click a button and I can see the blood pressures over time. I'm not like thumbing through pages to say, "What was your last blood pressure?" "Oh, and what was the one before that?" and then try to think about them. I click a button and [the EHR] graphs them for me. I can see trends. I can see what's been happening. It is incredible in facilitating communication. I mean, we have a huge practice, ... and we work together as a team. How would you do that on paper?

Real World Applications and Challenges: Usability Solutions

*Speech Understanding: m*modal*

SNOMED-CT

Tagged content	Transcript of physician's words
<p>Tobacco use None</p> <p>Alcohol use Occasional</p> <p>Penicillin</p> <p>250 mg, 1/day</p> <p>Hydroxyurea</p> <p>500 mg, 2/day</p>	<p>Negative for tobacco use, but likes to have a glass wine on occasion.</p> <p>On admission he was on penicillin 250mg a day and hydroxyurea 500mg twice a day.</p>

Real World Applications and Challenges: Usability Solutions

Clinically Adaptive EHR

The clinician interacts with models and abstractions of the patient that **place the raw data into context and synthesize them with medical knowledge in ways that make clinical sense for that patient.**

These virtual patient models are the computational counterparts of the clinician's conceptual model of a patient.

The use of these models to **establish clinical context**, would free the clinician from having to make direct sense of raw data, and thus he or she would have a much easier time defining, testing, and exploring his/her own working theory.

What links the raw data to the abstract models might be called medical logic—that is, computer-based tools that **examine raw data relevant to a specific patient and suggest their clinical implications** given the context of the models and abstractions.

Computers can then provide decision support—that is, tools that help clinicians decide on a course of action in response to an understanding of the patient's status.

Real World Applications and Challenges: Usability Solutions

Clinically Adaptive EHR: Praxis

— SINGLE & SOLO PHYSICIAN PRACTICES: ALL SPECIALTIES

- 1 PRAXIS
- 2 HEALTHFUSION
- 3 DRCHRONO
- 4 KAREO
- 5 ATHENAHEALTH
- 6 MODERNIZING MEDICINE
- 7 ADP ADVANCEDMD
- 8 PRACTICEFUSION
- 9 NEXTECH
- 10 CARECLOUD

— INTERNAL MEDICINE

- 1 – PRAXIS
- 2 – CARECLOUD
- 3 – ATHENAHEALTH
- 4 – CERNER
- 5 – PRACTICE FUSION
- 6 – KAREO
- 7 – NEXTGEN
- 8 – ALLSCRIPTS
- 9 – GREENWAY
- 10 – CARE 360 QUEST MEDPLUS #^)

Buy the full Report

“Datum” auto populates from patient’s record
can be calculated (e.g. BMI)

Information that must be edited for this patient

History Of Present Illness

225% Clipboard Spell check Bracket Checker ☒ Reduce PraxCoder Datum Save Save with Knowledge Cancel

Patient Context Zone

HPI

«Mary» is a «31 y.o.» who presents with a sore throat for [4 days], nasal congestion for [2 days], fever for [3 days], and general malaise. *She denies cough, and denies diarrhea. She also denies any dizziness, rash, trismus, or headaches. Patient denies any dysphagia. She denies any nasal drainage. She does not snore. Denies any bleeding. She denies any history of bad breath. Patient denies any bug bites. Patient denies any nausea or vomiting. Patient denies chest pain or shortness of breath. She denies any ear aches. Patient denies any ear pain.*

She also complains of weakness, tiredness, or cramping in arm or leg muscles. Her last Potassium level was «5.1» meq/L taken on «07/17/2011».

«Mary» is also overweight. Her current weight is «170» lbs. (with a body mass index of «33.2» Kg/m2). Her previous weight on «07/17/2011» had been «69.2» lbs.

Clayton Reynolds, M... Imaginary, Mary 31 y...

11:21 AM

Clicking accepts this “clinical concept”

Real World Applications and Challenges: Usability Solutions

Reinvent the EHR: MCIS



EHR

A cloud-based EHR designed to optimize care team workflow, MCIS Clinicals produces an easy-to-read clinical note generated from structured data collected during the visit.

[Learn more](#)



Analytics

Industry-leading analytics that provide real-time insight into your practice, making it actionable before, during and after the patient visit.

[Learn more](#)



Patient Portal

Sophisticated patient portal that drives patient engagement beyond the office visit with access to their health information and care team anywhere, anytime.

[Learn more](#)

Real World Applications and Challenges: Usability Solutions

Reinvent the EHR: MCIS

The screenshot displays the MCIS Clinicals interface. At the top, there's a navigation bar with tabs for 'Schedule', 'Work Lists', 'Population Health' (selected), and 'Meaningful Use'. Below this, a patient profile for 'Key, Tashya (95069)' is shown. The 'Patient Information' section includes fields for Preferred Contact, Attributed Provider, Next Appt, HCC Risk Score, and Hospitalization Risk. The 'Condition List' section features a table with columns: Quality Measure, Trending, At Goal, Goal, Value, Date, Due Date, and Status. The table lists various conditions and their associated goals and values. A sidebar on the left contains icons for GENERAL, PANEL, WELL, DX, PEER, and PT LIST. A vertical 'Actions' menu is on the right.

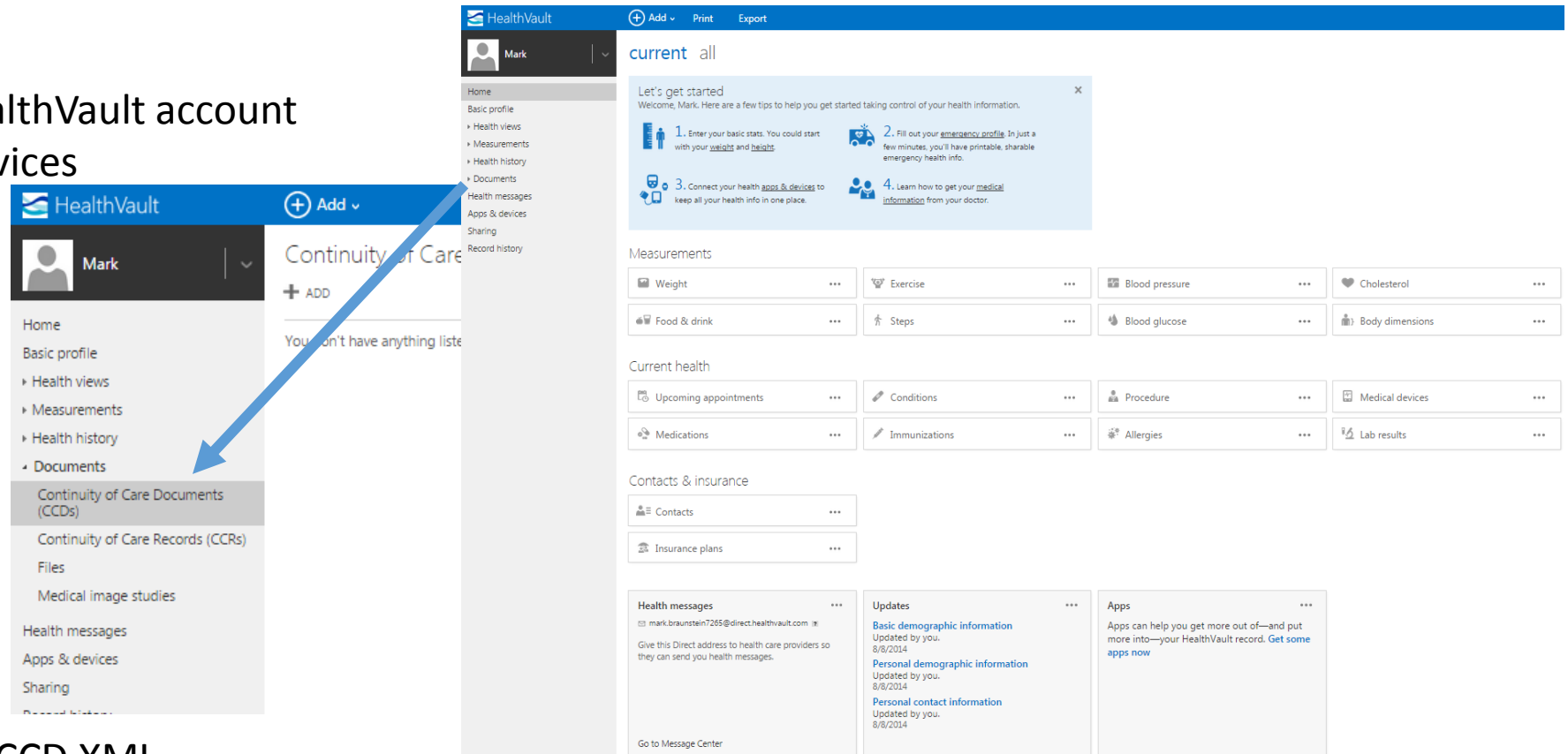
Quality Measure	Trending	At Goal	Goal	Value	Date	Due Date	Status
BMI Care Plan		❌	Process Goal	NO	12/28/2014	None	
Flu Vaccine		❌	Process Goal	NO	11/07/2014	None	
Fall Risk Assessed		✅	Process Goal	Assessed	04/15/2014	None	
Osteoporosis Screening		✅	Process Goal	YES	06/20/2014	None	
Colorectal Cancer		✅	Process Goal	YES	04/25/2014	None	
Diabetes Care Plan		✅	Process Goal	YES	12/12/2014	None	
Foot Exam		✅	Process Goal	1	09/21/2014	None	
LDL Control		✅	100	86	09/11/2014	None	

Interview with Bradley P Bekkum, MD

Real World Applications and Challenges

Personal Health Records *HealthVault*

Create your own HealthVault account
Explore apps and devices



1. Upload Marla's CCD XML
2. Add all her data
3. Manually add some weights
4. Chart her weight



Health Informatics on FHIR

Real World Applications & Challenges: Workflow/Process

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Health Informatics on FHIR

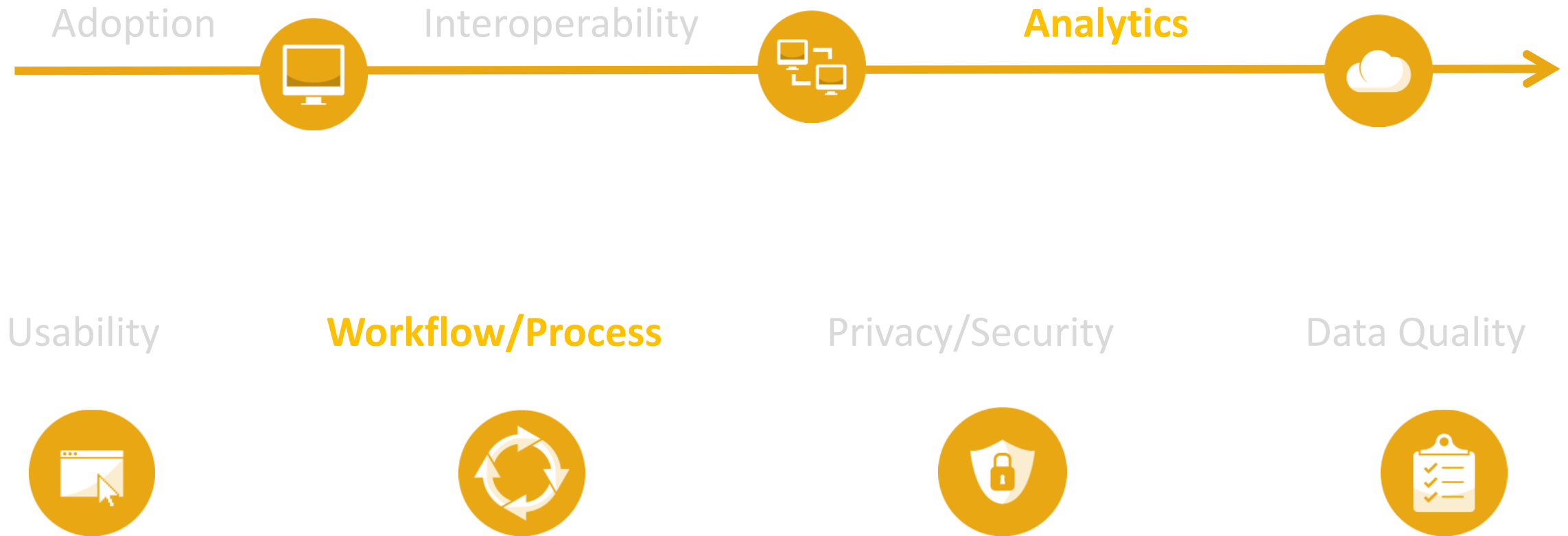
Real World Applications & Challenges: Workflow/Process

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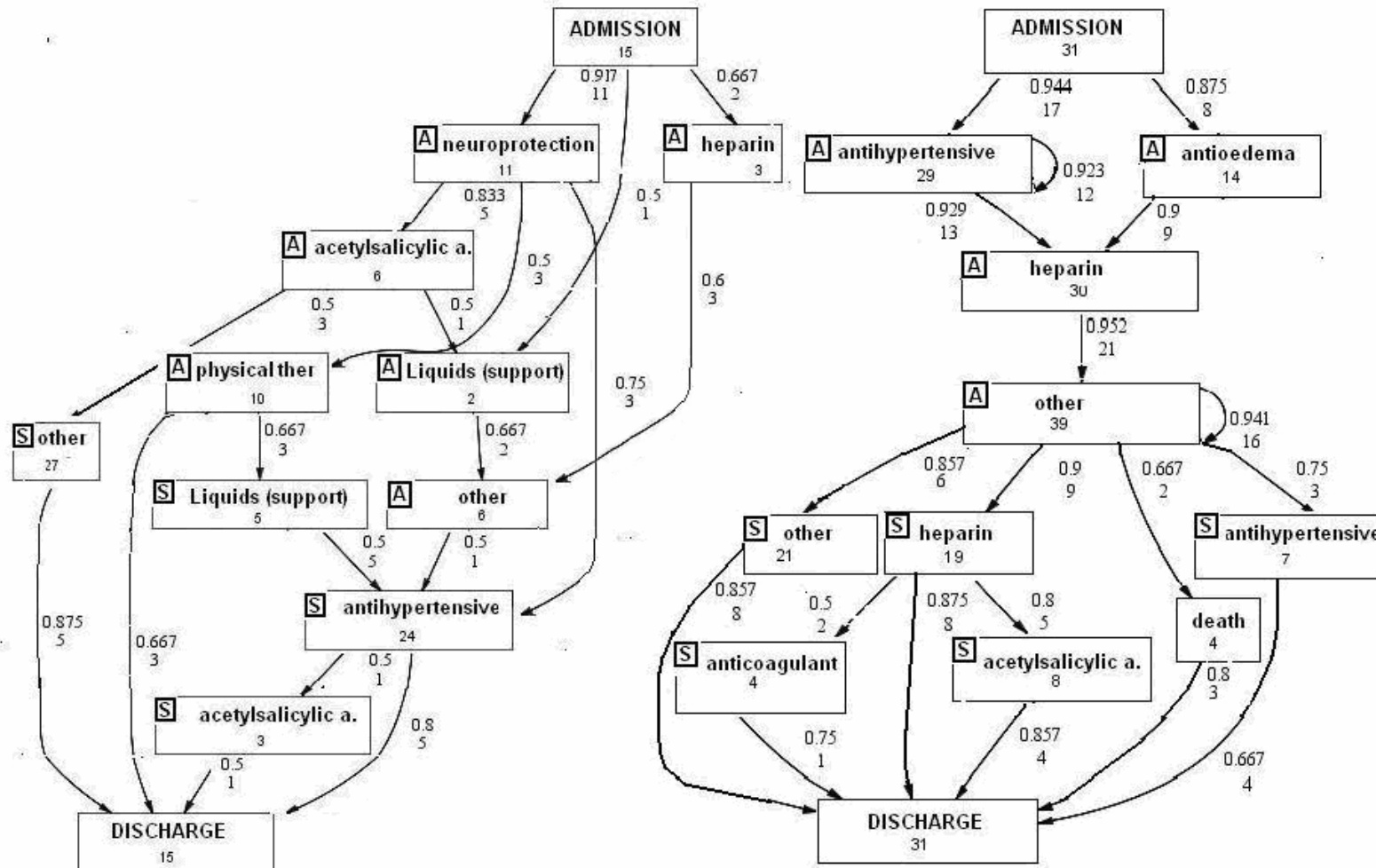


Real World Applications and Challenges: Workflow/Process



Real World Applications and Challenges

Workflow/Process: *Process Mining*







Health Informatics on FHIR

Real World Applications & Challenges: Privacy/Security

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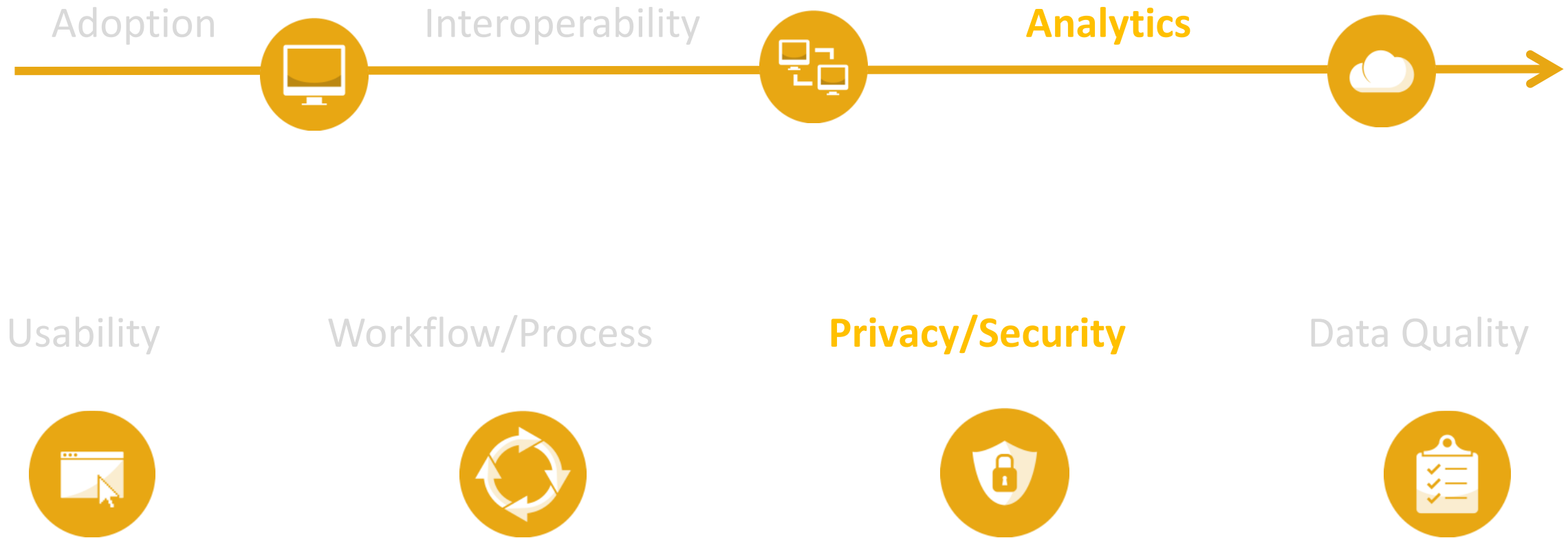
Health Informatics on FHIR

Real World Applications & Challenges: Privacy/Security

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Real World Applications and Challenges: Privacy/Security



Real World Applications and Challenges:

Privacy/Security

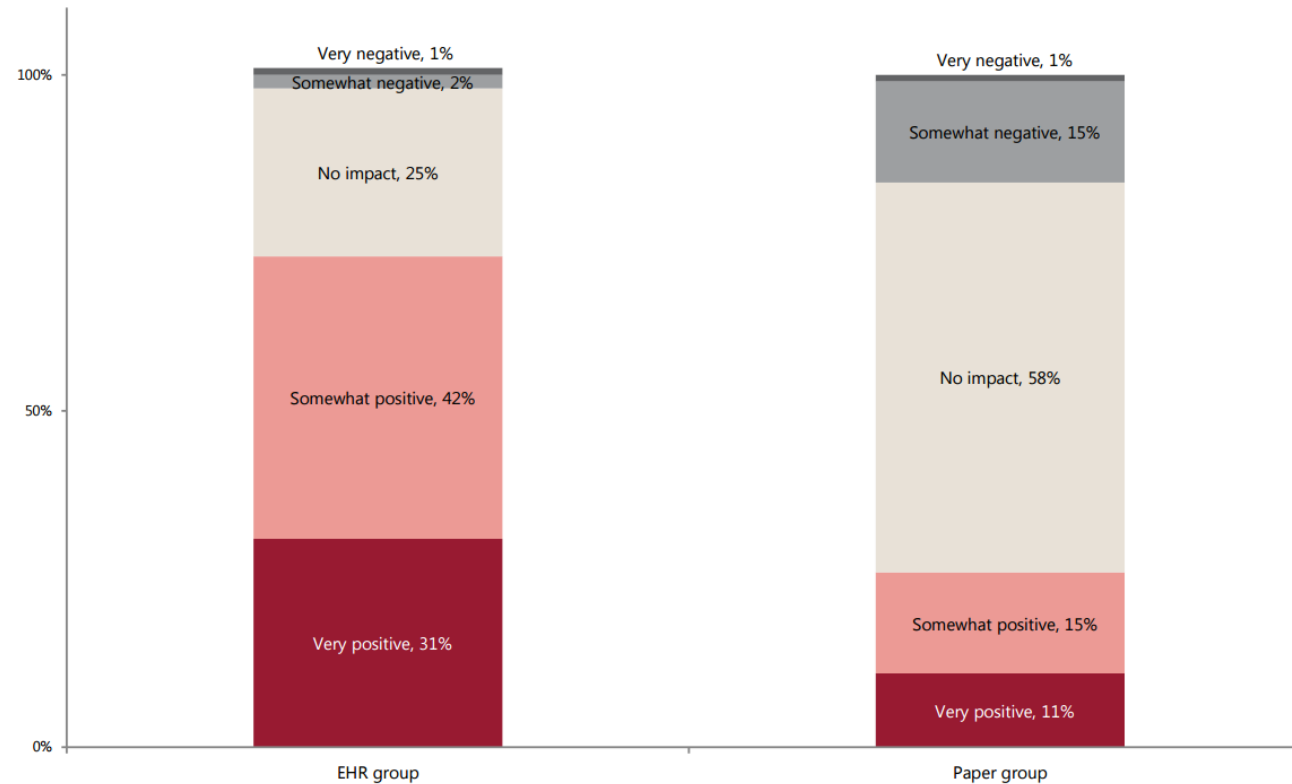
“long and sometimes heated debate on the appropriate approach to the privacy of patients and confidentiality of their data has stalled the development of a framework that protects confidentiality while supporting the legitimate use of data for improving quality, research and public health. Unquestionably, privacy is a valuable and valued social good. But so too are altruism, health and freedom. **Currently, health information policy seems to be giving too much weight to privacy at the expense of freedom and health.**”

--Don E Detmer, MD

Real World Applications and Challenges: Privacy/Security

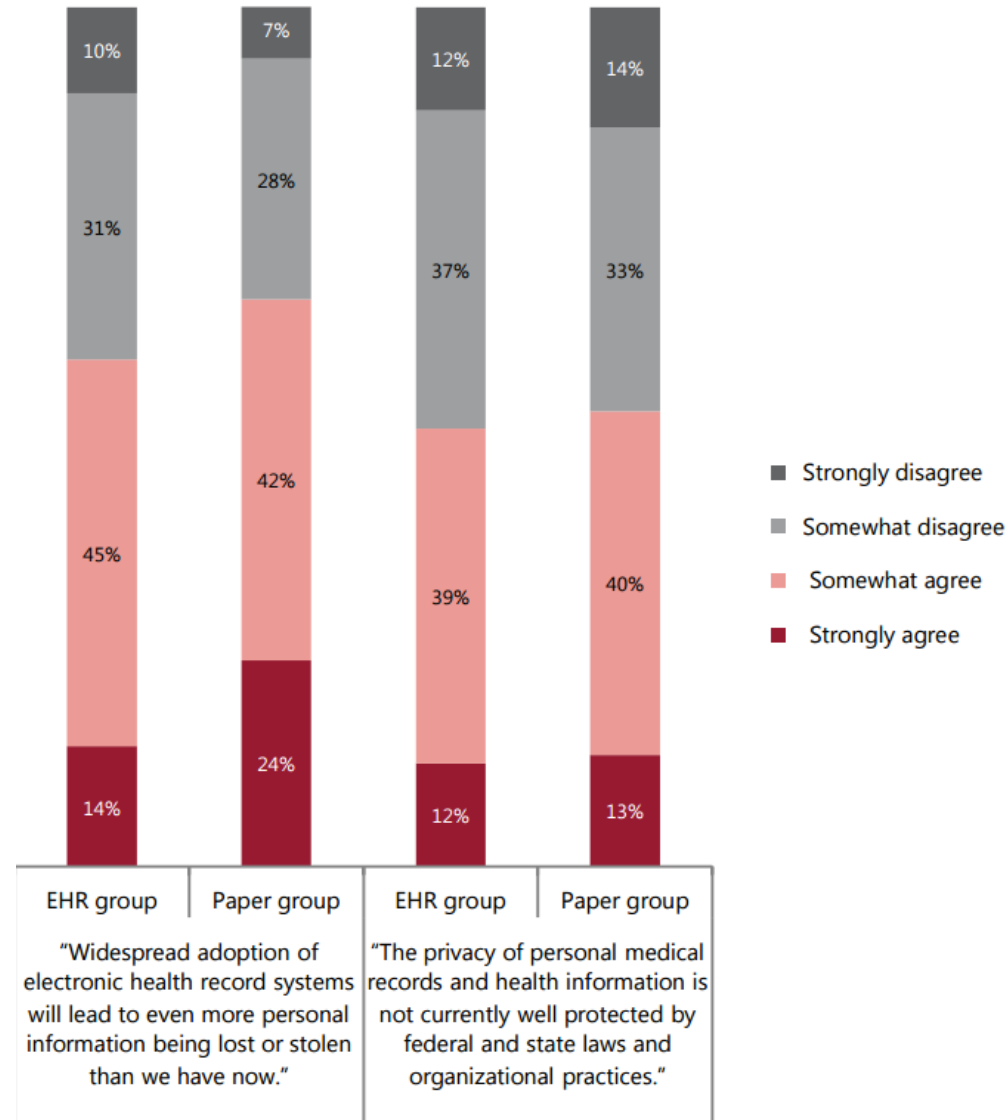
**What impact do you believe your doctor's use
of an EHR / paper medical record system
has on the overall quality of your health care services?**

Base = EHR group (n=1153) and paper group (n=808)



Real World Applications and Challenges:

Privacy/Security



Real World Applications and Challenges:

Data Types

- Protected Health Information (PHI)
- De-identified Health Information
- Synthetic Health Information

Real World Applications and Challenges: PHI

- Protected Health Information (PHI)
 - De-identified Health Information
 - Synthetic Health Information
- HIPAA
- 

Real World Applications and Challenges: TPO

- Protected Health Information (PHI)
- De-identified Health Information
- Synthetic Health Information

Treatment, Payment, and Health Care Operations
(TPO)



T: Referral

P: Claims

O: Quality Reporting



Real World Applications and Challenges: De-identified

- Protected Health Information (PHI)
- De-identified Health Information
- Synthetic Health Information

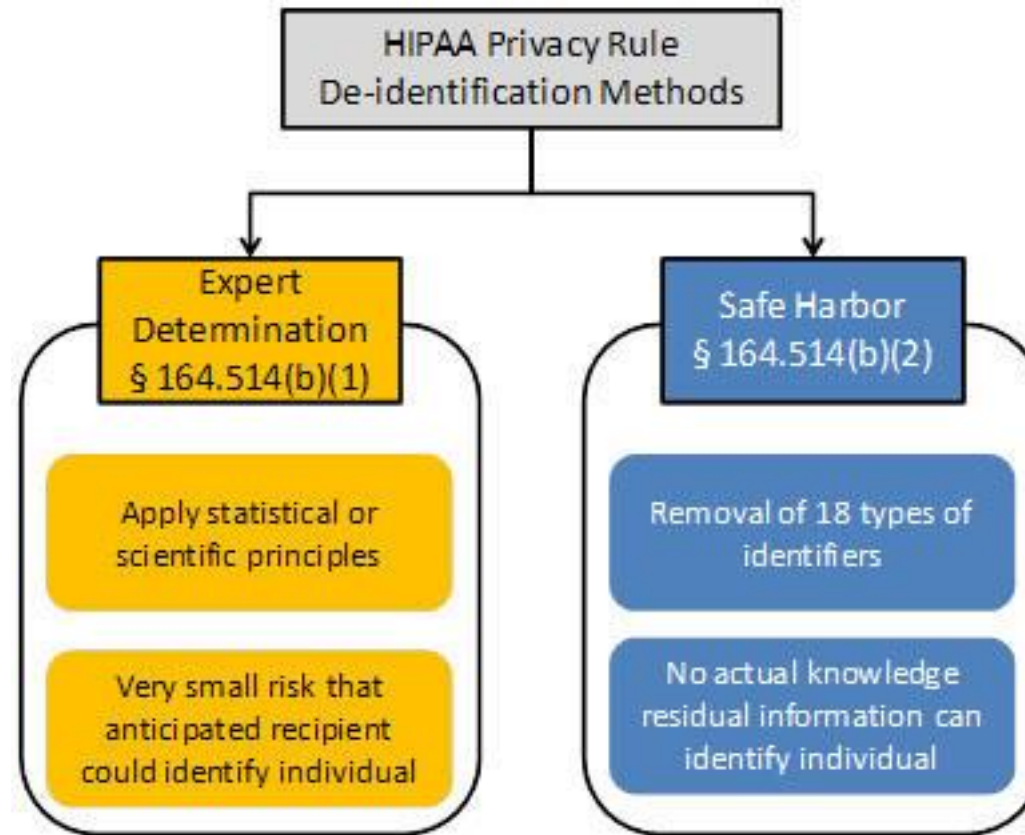
Research



Real World Applications and Challenges: De-identification


- Protected Health Information (PHI)  ?
- De-identified Health Information 
- Synthetic Health Information

Real World Applications and Challenges: De-identification



Real World Applications and Challenges: De-identification

Analytic Tool for Expert Method


Module F: Domain Extraction (demo)

This module allows you to specify specific domains of interest and extract them as AL-PUF variables.


Observations: 2326856
Variables: 39 ⓘ
Transformed Variables: 89 ⓘ
Strata: 24 ⓘ
Groups: 64 ⓘ
Micro Groups: 155170 ⓘ
Schema ⓘ

Back to Project Menu

Here are the results for your disclosure and low utility events for each of the sampling schemes you ran through the simulator. Using the slider below, you can select the scheme with the highest utility given a maximum probability of a disclosure event occurring. The schemas that fall under the desired threshold for a disclosure event occurring will be highlighted in green, of these the schema with the highest utility will have bolded text.

Balance

Risk Threshold: 0.07



S1	S2	S3	Disclosure Risk	Utility	Select Scheme
90	90	60	0.088	0.94	Select Scheme
90	90	40	0.074	0.886	Select Scheme
90	90	20	0.068	0.748	Select Scheme
90	80	60	0.04	0.926	Select Scheme
90	80	40	0.042	0.866	Select Scheme
90	80	20	0.02	0.722	Select Scheme

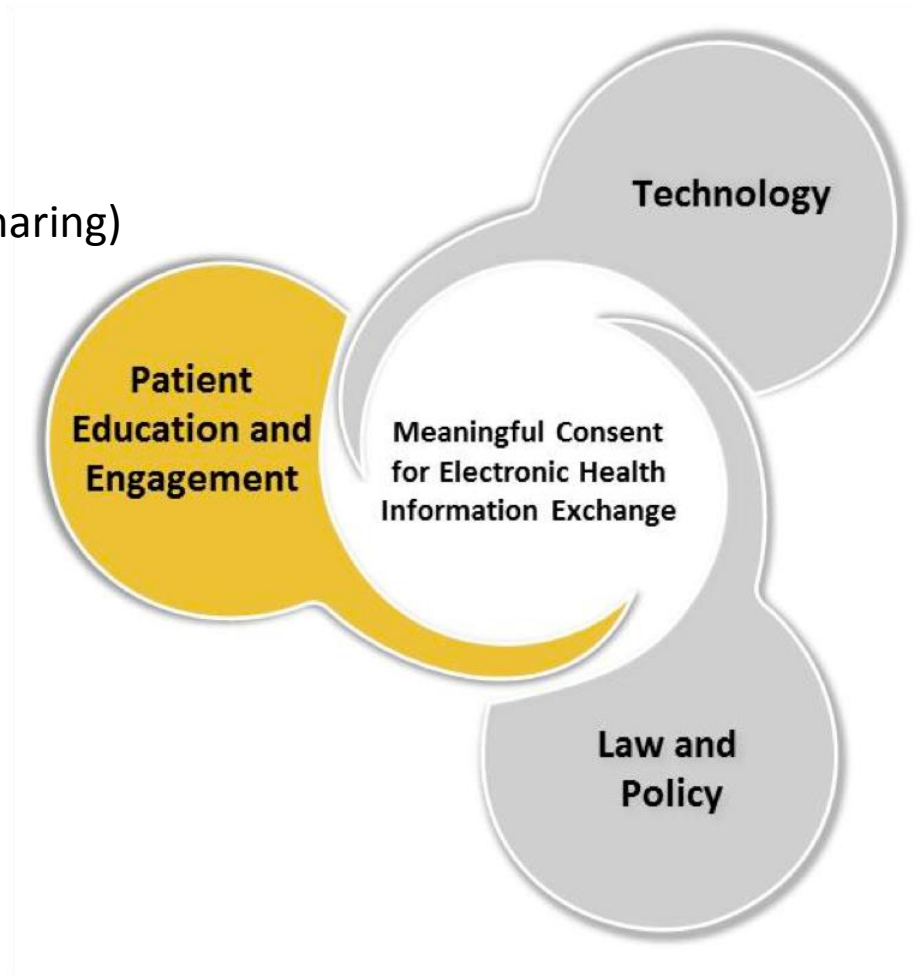
Real World Applications and Challenges: Privacy/Security

Patient Consent

No Consent (all data shared)
 Opt In (only shared with consent)
 Opt Out (no sharing)
 Opt In with Exceptions (only patient specified sharing)

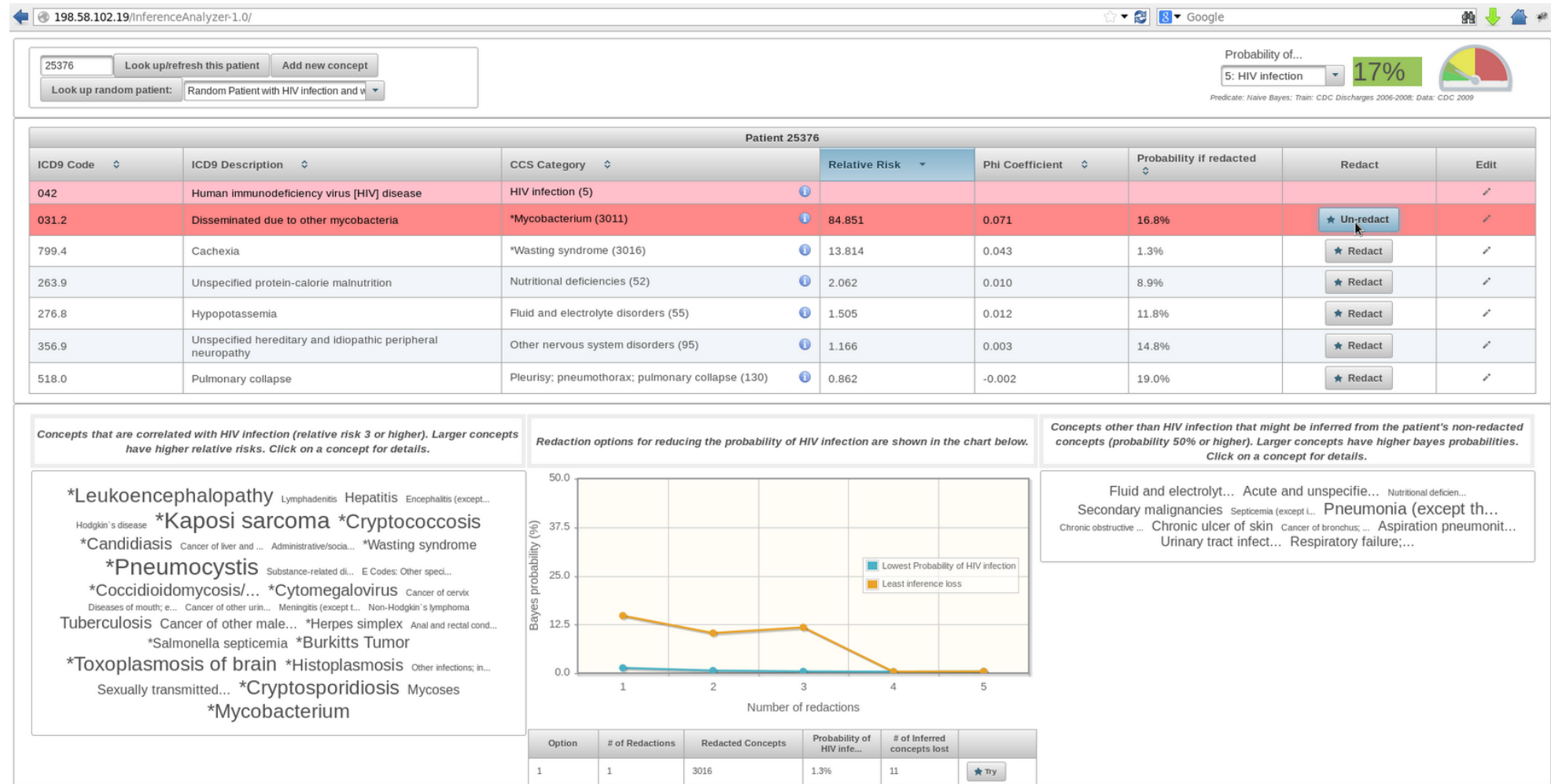


“Optimal” but requires segmentation

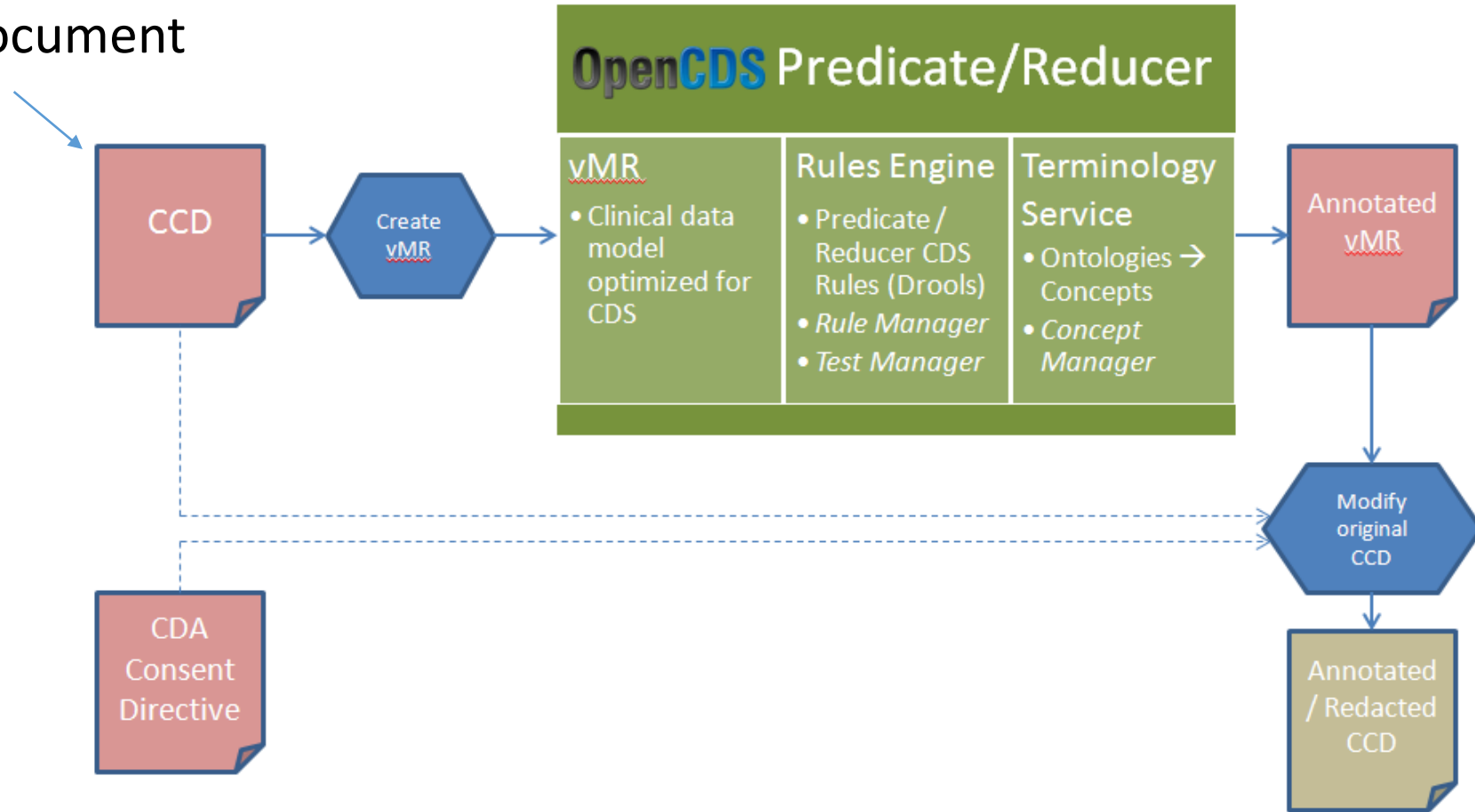


Real World Applications and Challenges: Privacy/Security

Analytic Tool for Data Segmentation



Key TOC document
standard



Redacted CCD based
on patient's data
sharing preferences

107.170.66.72/cda-ws-web/

Predicate Reducer

Select ILHIE classifications to disclose:(leave blank to redact all classifications)

☐ HIV (ILHIE_HIV)

☐ Mental Health (ILHIE_MentalHealth)

☐ Substance Abuse (ILHIE_SubstanceAbuse)

Upload file for reducing:

+ Choose a CCD file:

Summary of key clinical facts from selected parts of the the Virtual Medical Record (vMR)

Problems

1. Pneumocystosis (SNOMED-CT 88860002) **ILHIE_HIV**
2. Candidiasis of lung (SNOMED-CT 3487004) **ILHIE_HIV**
3. Other specified bacterial infections in conditions classified elsewhere and of unspecified site, mycoplasma (SNOMED-CT 95889002)
4. Acute maxillary sinusitis (SNOMED-CT 68272006)
5. Acute alcoholic intoxication in alcoholism, unspecified (SNOMED-CT 191802004) **ILHIE_SubstanceAbuse**
6. Other and unspecified alcohol dependence, unspecified (SNOMED-CT 361272001) **ILHIE_SubstanceAbuse**
7. Alcohol withdrawal delirium (SNOMED-CT 8635005) **ILHIE_SubstanceAbuse**
8. Anxiety disorder in conditions classified elsewhere (SNOMED-CT 17496003) **ILHIE_SubstanceAbuse**
9. Narcolepsy, without cataplexy (SNOMED-CT 60380001) **ILHIE_MentalHealth**
10. Cocaine abuse, unspecified (SNOMED-CT 78267003) **ILHIE_SubstanceAbuse**
11. Attention deficit disorder without mention of hyperactivity (SNOMED-CT 35253001) **ILHIE_MentalHealth**
12. Histoplasmosis, unspecified, without mention of manifestation (SNOMED-CT 12962009) **ILHIE_HIV**

Substance Administration

1. azithromycin (RxNorm 18631)
2. fluconazole (RxNorm 4450)

Encounters

Procedures

Version: 1.0



Health Informatics on FHIR

Real World Applications & Challenges: Data Quality

Mark L Braunstein, MD
School of Interactive Computing





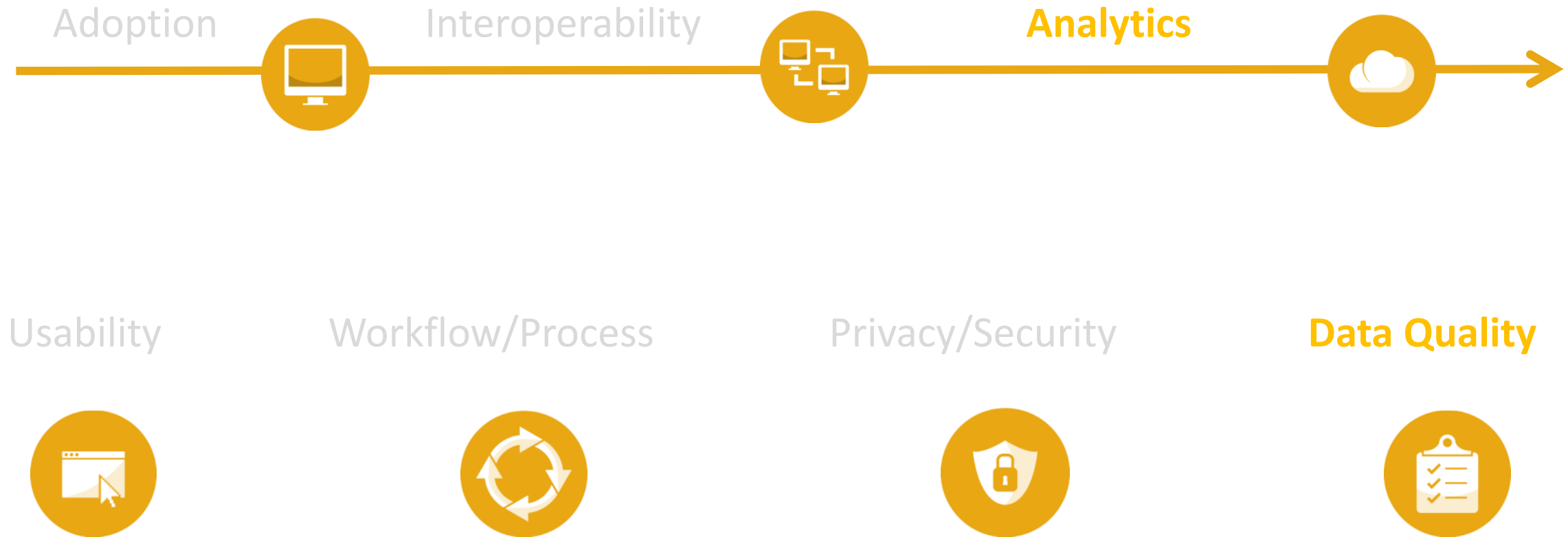
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Real World Applications and Challenges: Data Quality

Common Data Quality Issues

Heterogeneous (free text, codes, images, continuous analog/digital measures)

Missing or inaccurate values

Inaccurate or missing data/time stamps

Dynamic and evolves over time

Type 2 diabetes in a newborn



Also various levels from individuals to processes, enterprises or the delivery system (modeling challenge)

Real World Applications and Challenges: Data Quality

Accurate Problem Lists

Problem List Suggestion

Based on patient's clinical and billing data, the patient may have the following problems. Upon save, checked items will be added to the problem list. Unchecked items will not be added, and you will not be prompted again.

[+ Expand All](#)

Add	Problem Description	
<input checked="" type="checkbox"/>	Coronary arteriosclerosis: Patient is taking a platelet aggregation inhibitor and has been billed at least once for CAD.	Enter Customizable Description...
<input checked="" type="checkbox"/>	Congestive heart failure: Patient is on at least two CHF medications and has been billed at least twice for CHF.	Enter Customizable Description...
		+ Related terms
<input checked="" type="checkbox"/>	Diabetes mellitus: Patient has a HbA1c \geq 7.0%.	Enter Customizable Description...
		+ Related terms
<input checked="" type="checkbox"/>	Hypertensive disorder: Patient has been billed for hypertension and is on an antihypertensive agent.	Enter Customizable Description...
		+ Related terms
<input checked="" type="checkbox"/>	Hypothyroidism: Patient is on thyroid hormone.	Enter Customizable Description...

[Explanations](#)

Save

Cancel