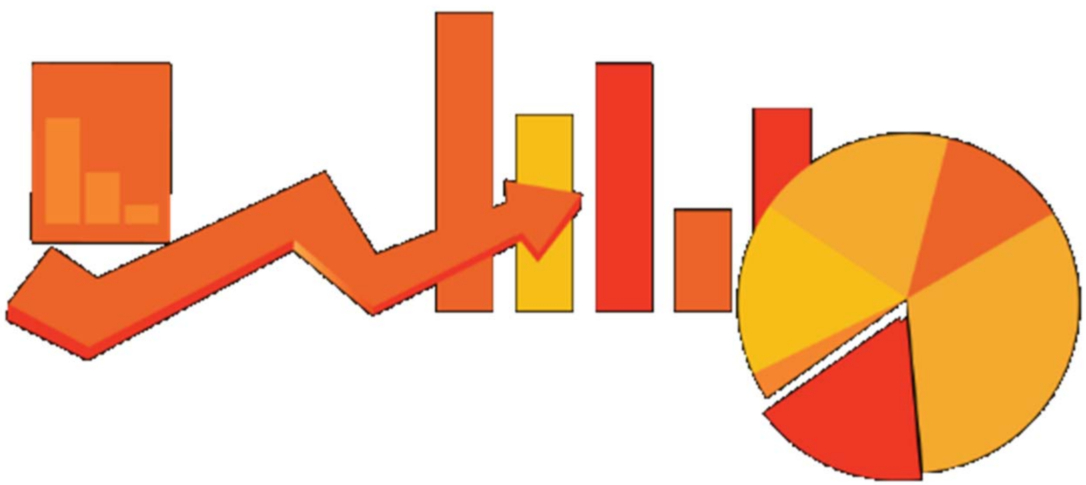
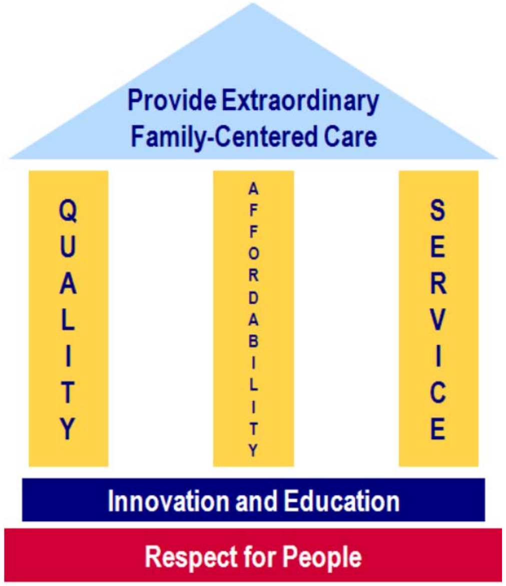
Analytics Track
AMDIS 2014

Moderated by Christopher Longhurst, MD, MS
VP of Analytics and Informatics
Stanford Children's Health



Stanford MEDICINE

Enable effective and efficient decision making through user-friendly access to quality information.



Stanford Children's Health | Lucile Packard Children's Hospital Stanford

The Gamut of Analytics

- Population health management
  Dick Gibson, MD, PhD
- Data Exploration at MetroHealth
  David Kaelber, MD, PhD
- Innovation and localization of data analytics at VA
  Sarah Russell, MD, MBA
- Text and waveform (big data) analytics at Stanford Children's
  Jon Palma, MD, MS and Veena Goel, MD
- Complex event processing
  Sameer Badlani, MD
- Panel Q&A – 30 mins
  All

Information Technology for Population Health Management

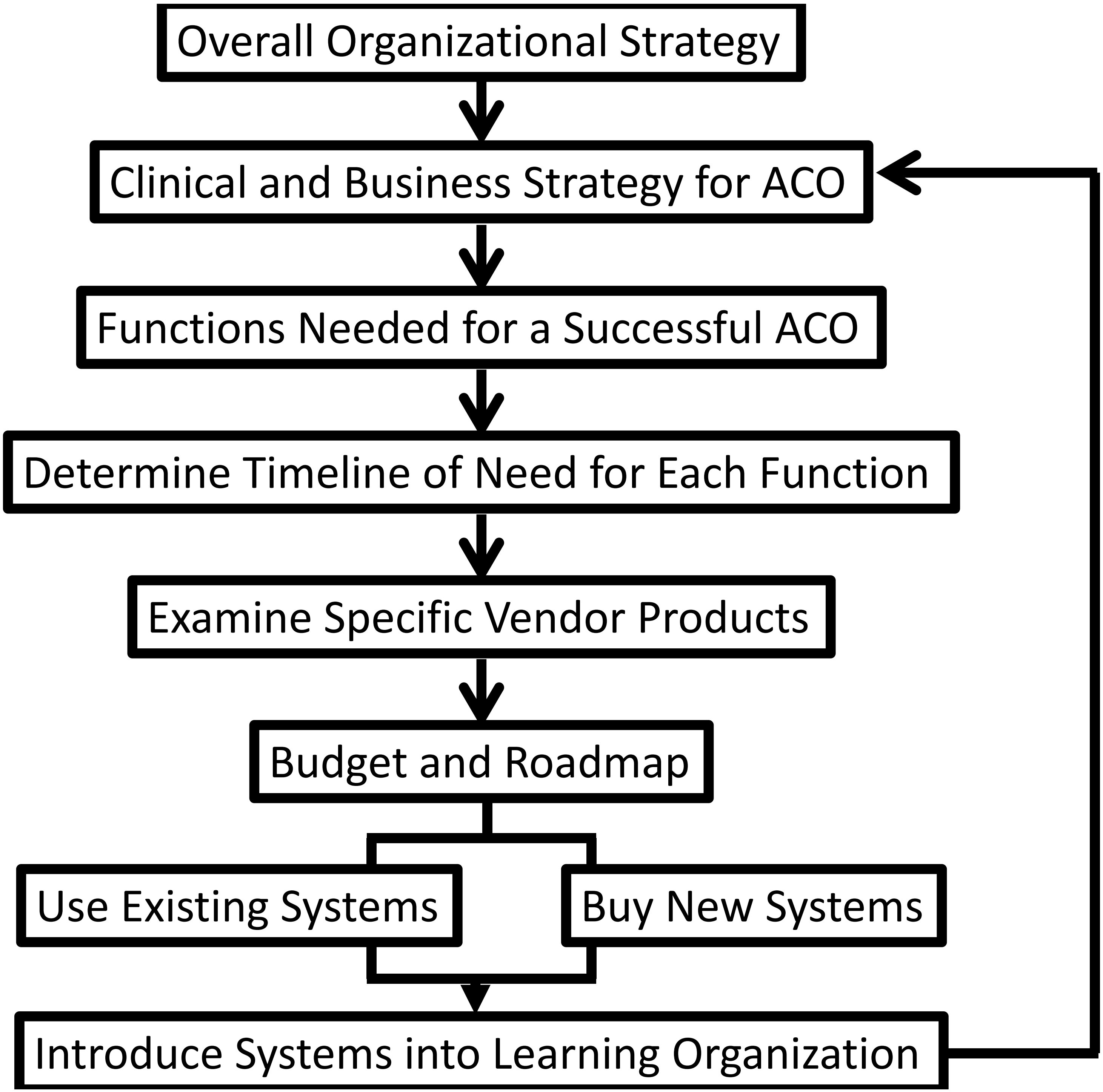
The Physician Computer Connection

AMDIS – Ojai

Thursday, 19 June 2014

Dick Gibson MD PhD

Portland OR


Overall Organizational Strategy
Clinical and Business Strategy for ACO
Functions Needed for a Successful ACO
Determine Timeline of Need for Each Function
Examine Specific Vendor Products
Budget and Roadmap
Use Existing Systems
Buy New Systems
Introduce Systems into Learning Organization

Major Functions of Population Health Management

- Provider Record of Care
- Patient & Family-facing Functions
- Attribution
- Risk Identification
- Group Tracking
- Care Planning
- Care Management
- Patient Outreach
- Performance Reporting
- Financial Management

Provider Record of Care

- Each professional has system to record useful information about the encounter, evaluation, or action taken
- Each professional can see the records of the other professionals either by viewing or importing (say with HIE)

Patient & Family-facing Functions

- Allows patient & family to enter their own data and respond to surveys
- Includes outcome analytics of value for the patient & family
- Includes report cards on providers and facilities
- Assists patient and family decision-making

Attribution of Patients to Providers

- Algorithm options: based on number of visits with primary care, most recent visit, intensity, total payments, CMS attrib
- Algorithms are transparent to providers

Risk Identification

- Which patients are most likely to get ill?
- Which patients would benefit most from intervention?
- What intervention is indicated?
- Will that intervention make a difference in outcome?

Group Tracking

- Identify patients by age, diagnosis, procedure, medication, labs, habits, health risk assessment, preventive care
- Updated promptly by action charted in EHR
- Single-patient report is viewable within EHR visit workflow
- Multi-patient reports are easily accessible

Care Planning

- The clinical content of Care Management
- For a given indicator/diagnosis, what is indicated to be done?
- Which providers need to do what by when?
- What does a given provider need to do today at the office visit

Care Management

- EVERY patient gets it
- may be done intermittently
- results in a single approved care plan
- done by clinical personnel
- same as Care Coordination

Case Management

- only SOME patients get it
- provided continuously
- assists with coordination of services
- assists with daily living skills
- assists with finding & maintaining housing, jobs, friends
- may provide transportation
- done by professionals and paraprofessionals

http://www.tacinc.org/media/13119/Managed%20Care.pdf

Care Management

- Organized by Care Goals and Long-term Care Plan
- Imports data from and sends data to Provider Record of Care
- Captures charting by Care Managers and Case Managers
- Uses the clinical content of the Care Planning system

Patient Outreach

- Manual selection of patients
- Automatic patient selection based on Group Tracking
- Manual deselection when contact would be inappropriate
- Library of campaign messages based on condition

Performance Reporting

- Patient clinical and financial outcomes by provider
- Provider productivity
- Identify providers to be coached, join, or leave network
- Ability to compare performance to benchmarks

Financial Management

- Cost of care analysis
- Analysis to negotiate contracts with providers and payers
- Out of network costs
- Benefit design and premium calculation

The Functions Overlap

Data Sources

Data Types	EHR	PHR/patient entered	provider billings	payer claims	pharm benefits mgr	local pharmacy	emp or payer survey (HRA)	home devices	lab company	public health or the state	CMS (MEDPAR)	employer files	credit card industry	Internet B2C firms
Age or date of birth	x	x	x	x	x	x	x	x	x	x	x	x	x	x
Address, zip, census	x	x	x	x	x	x	x	x	x	x	x	x	x	x
Ethnic background	x	x	x	x			x			x	x			x
Prior visit providers	x	x	x	x						x	x			
Prior visit cost			x	x						x	x			
History of current pr	x	x												
Health & risk habits	x	x					x							
Occupational histor	x	x					x			x		x		
Work absences		x					x					x		
Family history	x	x					x							
Prior surgeries	x	x	x	x			x			x	x			
Problem list	x	x	x	x	x	x	x			x	x			
Medication list	x	x		x	x	x	x				x			
OTC medications	x	x			x	x	x						x	
Allergies & intolerar	x	x			x	x	x							

System → Function ↓	EHR	Registry	Care MgtRec	Analy-tics	Manual Work	…
Provider Record	+++		+			…
Patient Facing	+/++		+			…
Attribution			+	+++		…
Risk Ident	+	++	+	+++	+	…
Group Tracking	++	+++	+/++	++/+++	+	…
Care Planning	+/++	+/++	++/+++		+	…
Care Managemt	+/++		+++			…
Patient Outreach	++/+++		?		++	…
Perform Report	+	+	+	+++	+	…
Financial Mgt				+++	+	…

Year 3

Year 2

Year 1

Function ↓ / System →	EHR	Registry	Care MgtRec	Analy-tics	Manual Work	…
Provider Record	+++		+			…
Patient Facing	+/++		+			…
Attribution			+	+++		…
Risk Ident	+	++	+	+++	+	…
Group Tracking	++	+++	+/++	++/+++	+	…
Care Planning	+/++	+/++	++/+++		+	…
Care Managemt	+/++		+++			…
Patient Outreach	++/+++		?		++	…
Perform Report	+	+	+	+++	+	…
Financial Mgt				+++	+	…

Questions?

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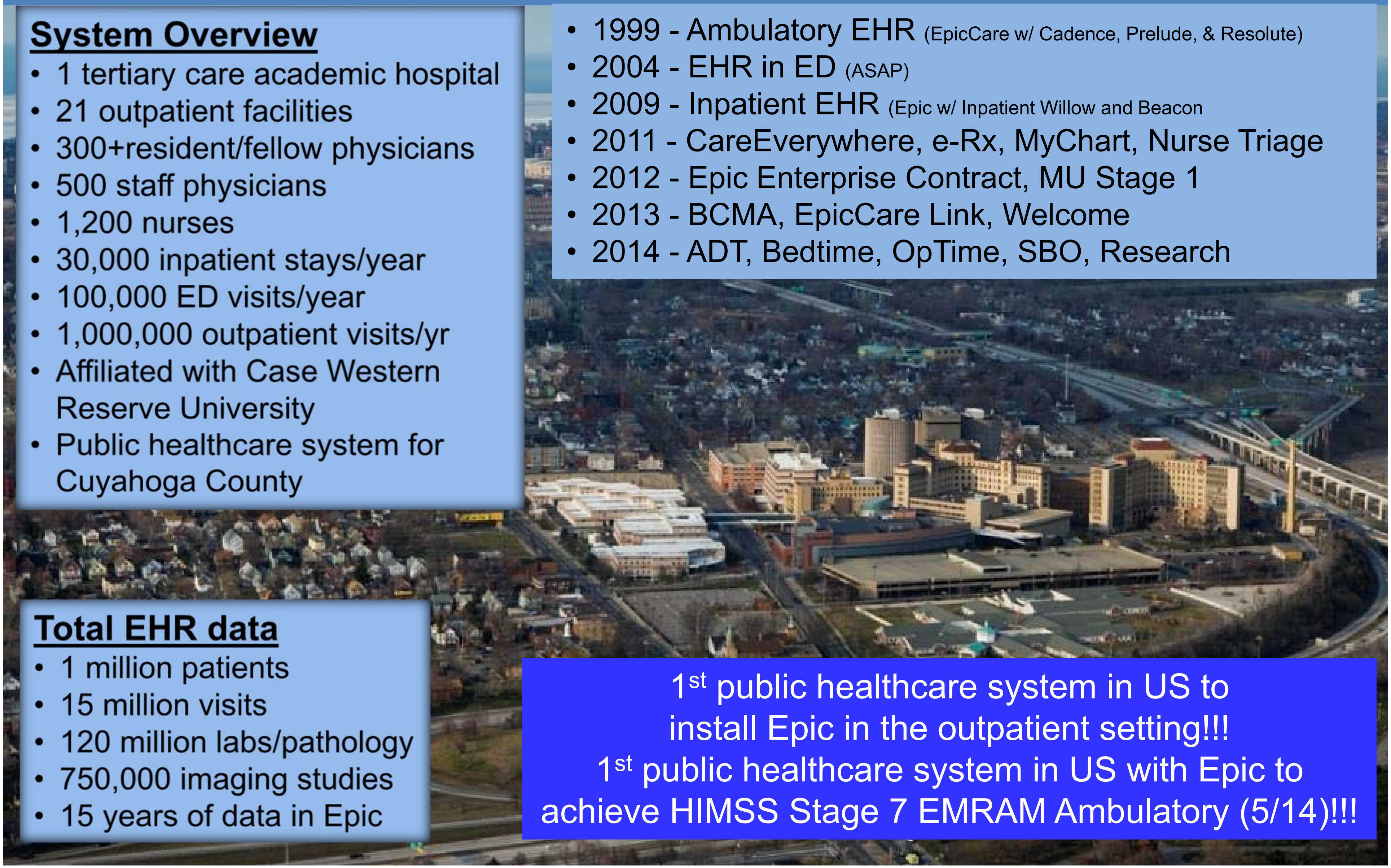
Data Exploration @ MetroHealth (3 cases)

David C Kaelber, MD, PhD, MPH, FAAP, FACP

Board Certified in Clinical Informatics
Associate Professor of Internal Medicine, Pediatrics, Epidemiology, and Biostatistics
Director of the Center for Clinical Informatics Research and Education
Chief Medical Informatics Officer
The MetroHealth System
Case Western Reserve University

MetroHealth and EHR (Epic)



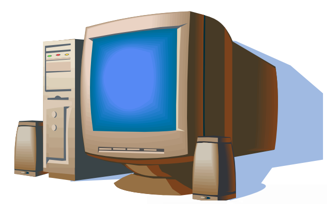
System Overview
- 1 tertiary care academic hospital
- 21 outpatient facilities
- 300+resident/fellow physicians
- 500 staff physicians
- 1,200 nurses
- 30,000 inpatient stays/year
- 100,000 ED visits/year
- 1,000,000 outpatient visits/yr
- Affiliated with Case Western Reserve University
- Public healthcare system for Cuyahoga County

- 1999 - Ambulatory EHR (EpicCare w/ Cadence, Prelude, & Resolute)
- 2004 - EHR in ED (ASAP)
- 2009 - Inpatient EHR (Epic w/ Inpatient Willow and Beacon
- 2011 - CareEverywhere, e-Rx, MyChart, Nurse Triage
- 2012 - Epic Enterprise Contract, MU Stage 1
- 2013 - BCMA, EpicCare Link, Welcome
- 2014 - ADT, Bedtime, OpTime, SBO, Research

Total EHR data
- 1 million patients
- 15 million visits
- 120 million labs/pathology
- 750,000 imaging studies
- 15 years of data in Epic

1st public healthcare system in US to install Epic in the outpatient setting!!!
1st public healthcare system in US with Epic to achieve HIMSS Stage 7 EMRAM Ambulatory (5/14)!!!

Case #1 - Pediatric Hypertension



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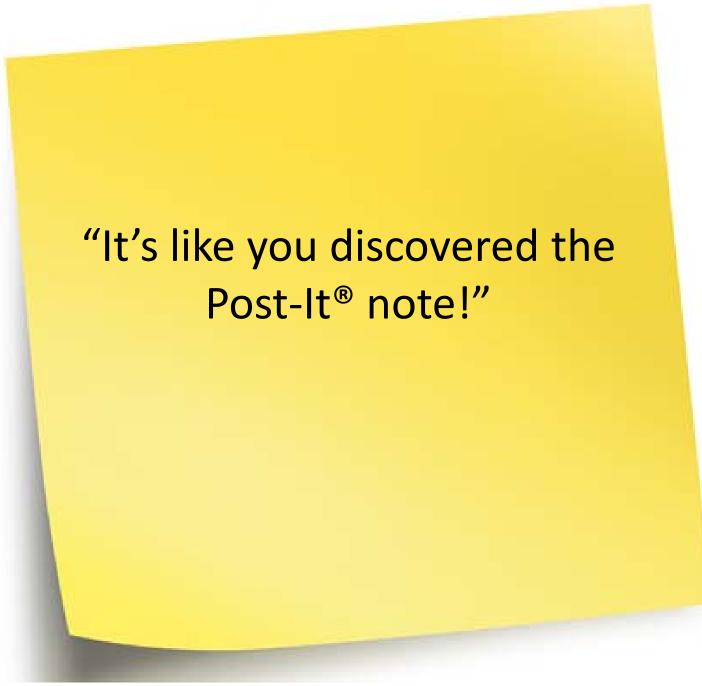
Case #1 - Pediatric Hypertension

Blood Pressure	*Adult*	*Children*
Normal	SBP ≤120 and/or DBP ≤80	SBP and/or DBP < 90% for gender, age, and height
Pre-hypertensive	SBP >120 and ≤139 and/or DBP >80 and ≤89	SBP and/or DBP ≥ 90% and < 95% for gender, age, and height
Stage I HTN	SBP >139 and ≤159 and/or DBP >89 and ≤99	SBP and/or DBP ≥ 95% and ≤ 99% +5mmHg for gender, age, and height
Stage II HTN	SBP >159 and/or DBP >99	SBP and/or DBP > 99% +5mmHg for gender, age, and height

Need 3 measurements for diagnosis of hypertension (HTN) or prehypertension (preHTN).

Case #1 - Pediatric Hypertension



JAMA.
2007;298(8)
:874-879

AHA Top 10 Research Advance of 2007!
Ladies' Home Journal **Healthcare Breakthrough Award of 2008!**

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Case #2 - Referral Completion

"The MetroHealth System is not reaching its financial revenue targets because expected patient volumes are down in both primary care and specialty care."

- MetroHealth CEO (summer 2011)

How can the CMIO/Informatics team help?

Finding value in health IT!

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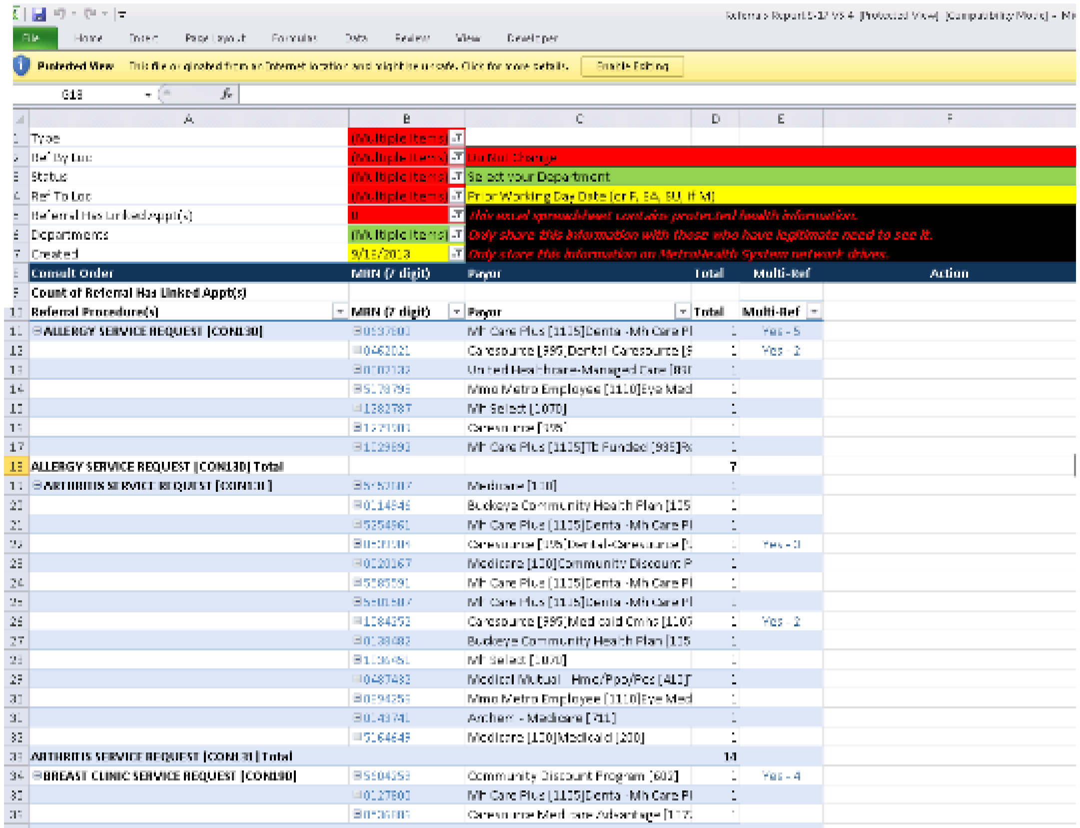
Case #2 - Referral Completion

Consults/procedure orders written yesterday not completed or scheduled today.

After 12 months (2/2012-2/2013) the 30-day consult and procedure completion/schedule rate went from 48% to:

Answer: 61%



~6700/month additional initial consults (61,939) and procedures (18,936) completed/scheduled (and ~$1,000,000/month in new gross revenue).

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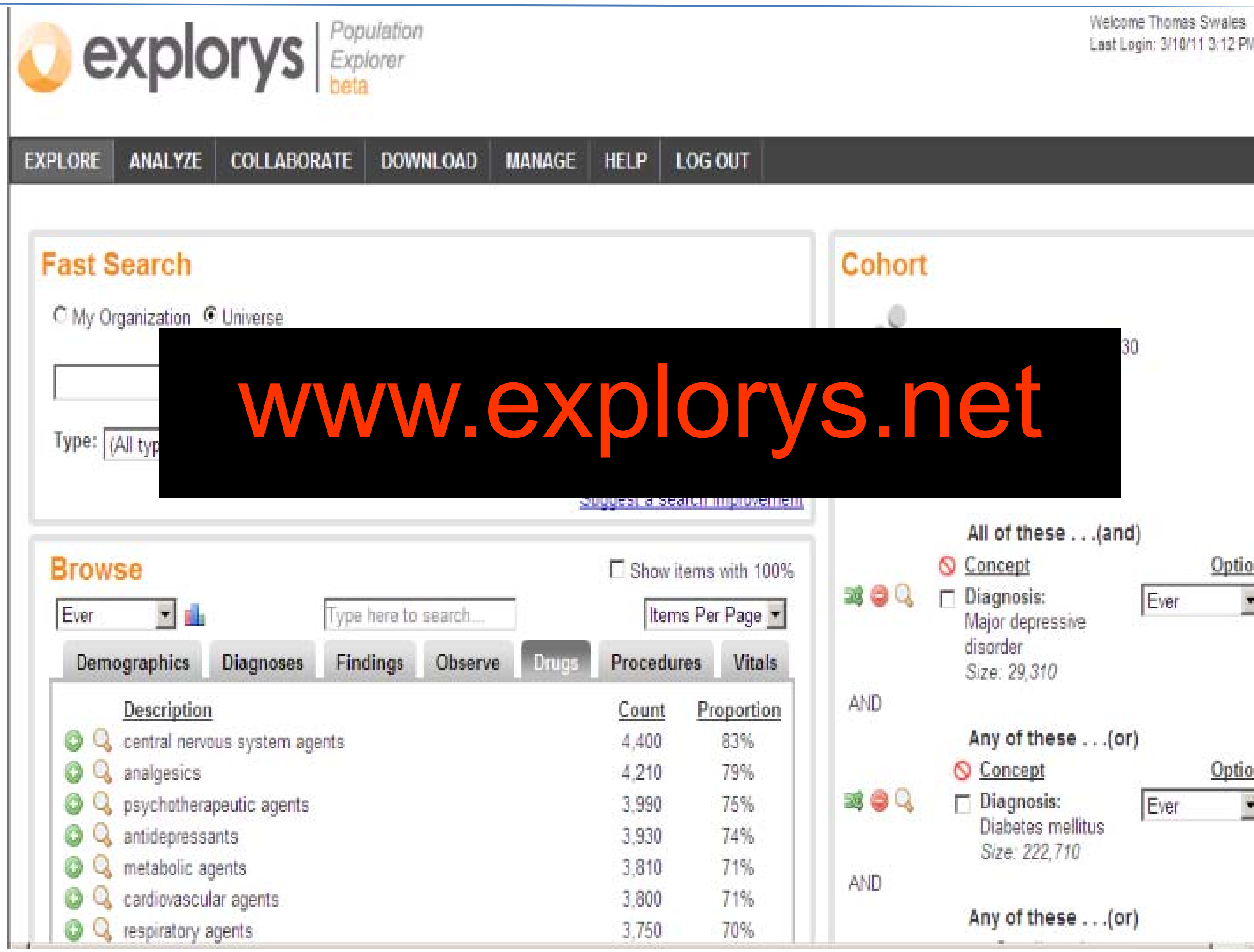
Case #3 – "Big Data"



www.explorys.net

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Case #3 – "Big Data"

- Pooled, normalized, standardized EHR data
- Over 40 million patients (6/17/2014; growing)
- Web interface (Google-like speed)
- Data Types
  - Demographic (gender, age, race/ethnicity, insurance, zip-3)
  - Diagnoses (ICD-9, SNOMED-CT)

Unified Medical Language System (UMLS)

Example – Post-market drug surveillance of Azathioprine (relatively rarely used drug with rare side effect); are side effects more/less or the equivalent to similar drugs

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Case #3 – "Big Data"

Side Effects Investigated

Side Effect	Lab Value	Abnormal Range
Anemia	Hemoglobin (Hgb)	<11 g/dL
Cell lysis	Lactate dehydrogenase (LDH)	>190 IU/L
Fever	Temperature	>37.8°F
Hepatotoxicity	AST, ALT	AST>40 IU/L and ALT>40 IU/L
Hepatotoxicity	Total bilirubin (Bili)	>1 mg/dL
Hypertension	Blood pressure (BP)	Systolic >140 mm Hg or Diastolic>90 mm Hg
Nephrotoxicity	Creatinine (Cr)	>1.5 mg/dL
Neutropenia	Neutrophil count	Count<57% or <2.5 cells/µl
Neutrophilia	Neutrophil count	Count>70%

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Case #3 – "Big Data"

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Case #3 – “Big Data”

Control cohort administered one of 12 anti-rheumatic drugs. Overlap is evident between the cohorts since controlling the AZA cohort for the absence of the other 12 drug.

Drug Name (RxCUI)	Control Cohort		AZA Cohort	
Abatacept (614391)	140	(0.1%)	60	(0.4%)
Adalimumab (327361)	2660	(2.1%)	650	(4.7%)
Azathioprine (1256)	3610	(2.8%)	13890	(100.0%)
Clioquinol (5942)	110	(0.1%)	0	(0.0%)
Etanercept (214555)	2490	(1.9%)	250	(1.8%)
Homatropine (27084)	66170	(51.1%)	680	(4.9%)
Hydroxychloroquine (5521)	22900	(17.7%)	2000	(14.4%)
Infliximab (191831)	2880	(2.2%)	1200	(8.6%)
Iodoquinol (3435)	7350	(5.7%)	80	(0.6%)
Leflunomide (27169)	1460	(1.1%)	480	(3.5%)
Methotrexate (6851)	17710	(13.7%)	1750	(12.6%)
Oxyquinoline (110)	220	(0.2%)	0	(0.0%)
Sulfasalazine (9524)	5320	(4.1%)	570	(4.1%)
Total	129560		13890	

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Case #3 – "Big Data"

Results

% of patients with comorbidities induced by AZA. Diagonal represents the proportion of patients experiencing a single side effect. Relative risk of developing a comorbidity (relative to any one of 12 anti-rheumatic drugs) is indicated by the cell color.

Primary Effect	Cr	AST, ALT	Bili	Neutro-penia	Neutro-philia	Temp	BP	Hgb	LDH
Cr	7.9%	30.8%	7.7%	15.4%	38.5%	53.8%	53.8%	69.2%	30.8%
AST, ALT	19.0%	14.1%	33.3%	9.5%	23.8%	33.3%	14.3%	47.6%	19.0%
Bili	4.5%	31.8%	14.1%	9.1%	45.5%	27.3%	36.4%	45.5%	13.6%
Neutropenia	2.4%	2.4%	2.4%	24.3%	0.0%	4.7%	8.2%	7.1%	0.0%
Neutrophilia	3.6%	3.6%	7.3%	0.0%	45.2%	7.3%	13.9%	18.2%	7.3%
Temp	15.6%	15.6%	13.3%	8.9%	22.2%	13.1%	60.0%	55.6%	4.4%
BP	4.6%	2.0%	5.3%	4.6%	12.5%	17.8%	29.5%	20.4%	2.0%
Hgb	16.1%	17.9%	17.9%	10.7%	44.6%	44.6%	55.4%	28.4%	19.6%
LDH	30.8%	30.8%	23.1%	0.0%	76.9%	15.4%	23.1%	84.6%	59.1%

Relative Risk[b]
1.00
1.25
1.50
1.75
2.00
2.25

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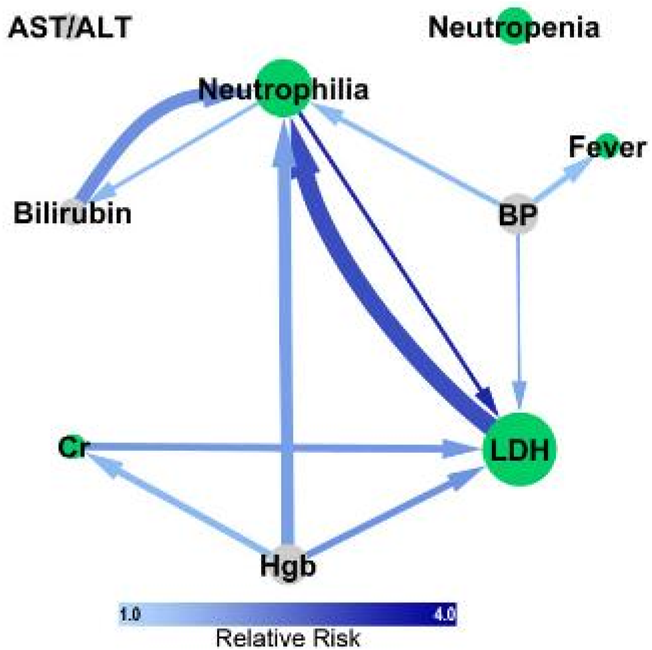
Case #3 – "Big Data"

Results

V Patel and **DC Kaelber**. *Using Aggregated, De-Identified Electronic Health Record Data for Multivariate Pharmacosurveillance: A Case Study of Azathioprine.* Journal of Biomedical Informatics (Special Clinical Research Informatics issue). 2013 Oct 28. pii: S1532-0464(13)00161-5. [Epub ahead of print] PMID:24177317.



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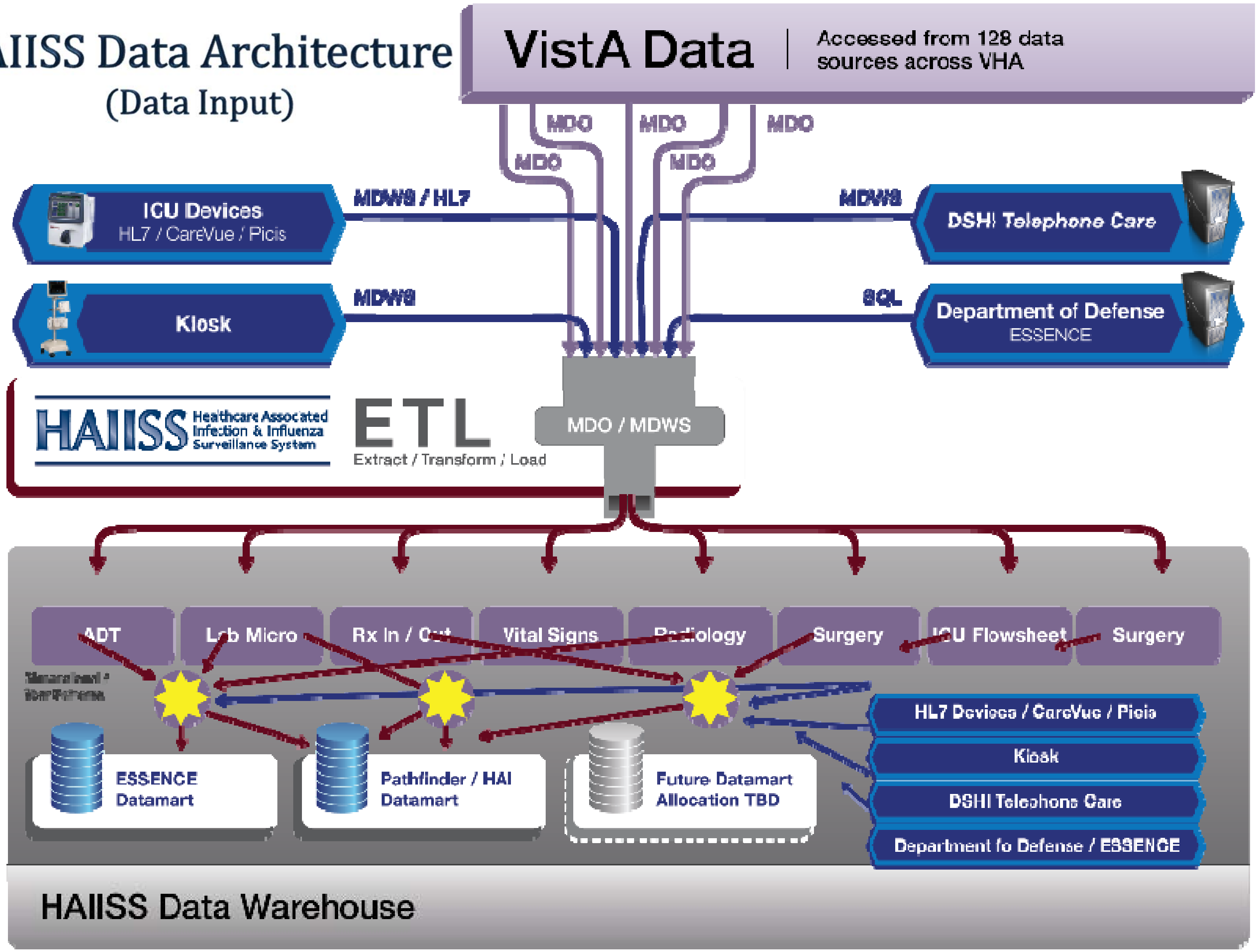
VA Clinical Informatics: Four programs highlighting advances and innovation in analytics

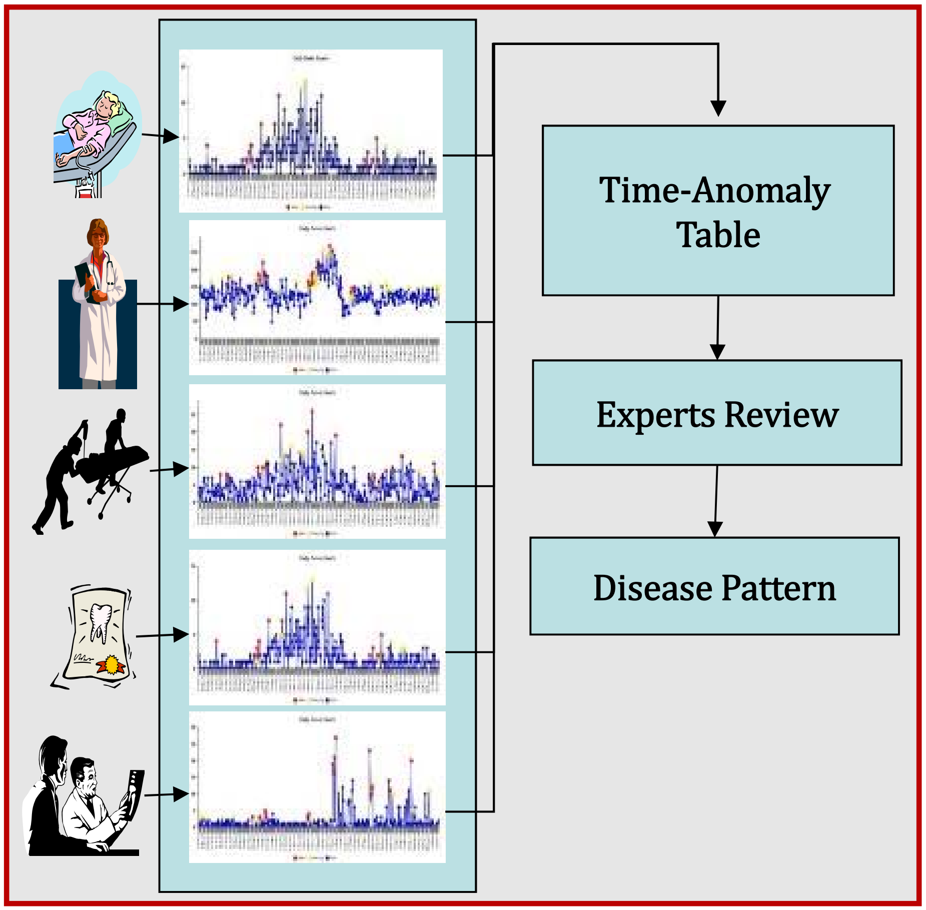
Sarah Russell, MD
sarah.russell@va.gov
CMIO, VA Palo Alto Healthcare System

- Clinical data driving bio-surveillance
- Corporate data warehouse and dashboards
- Patient engagement analytics
- Machine learning and free text analysis of the medical record

HAIISS Data Architecture
(Data Input)



Surveillance system approach

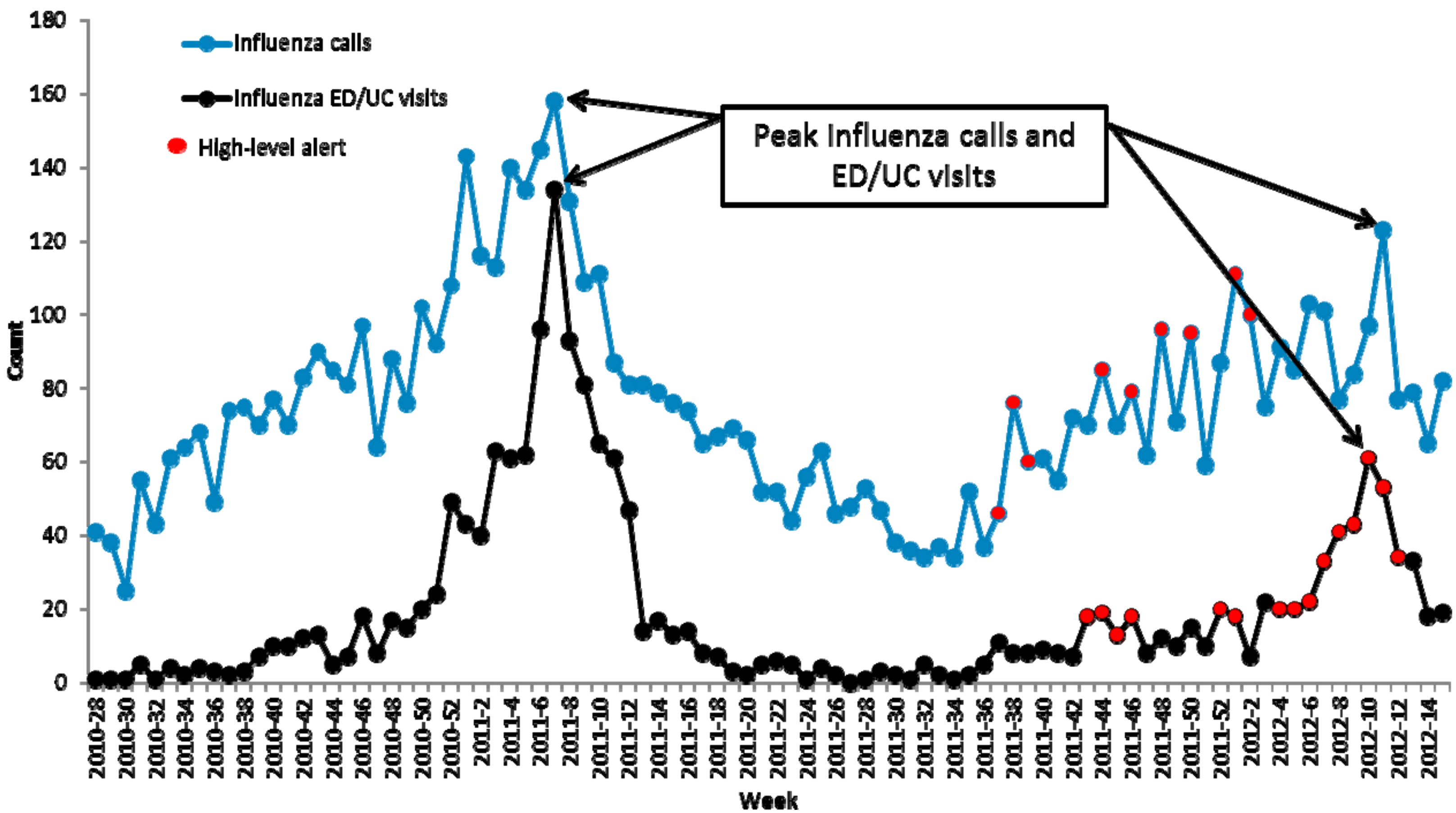


Step one: pull from heterogeneous data sources

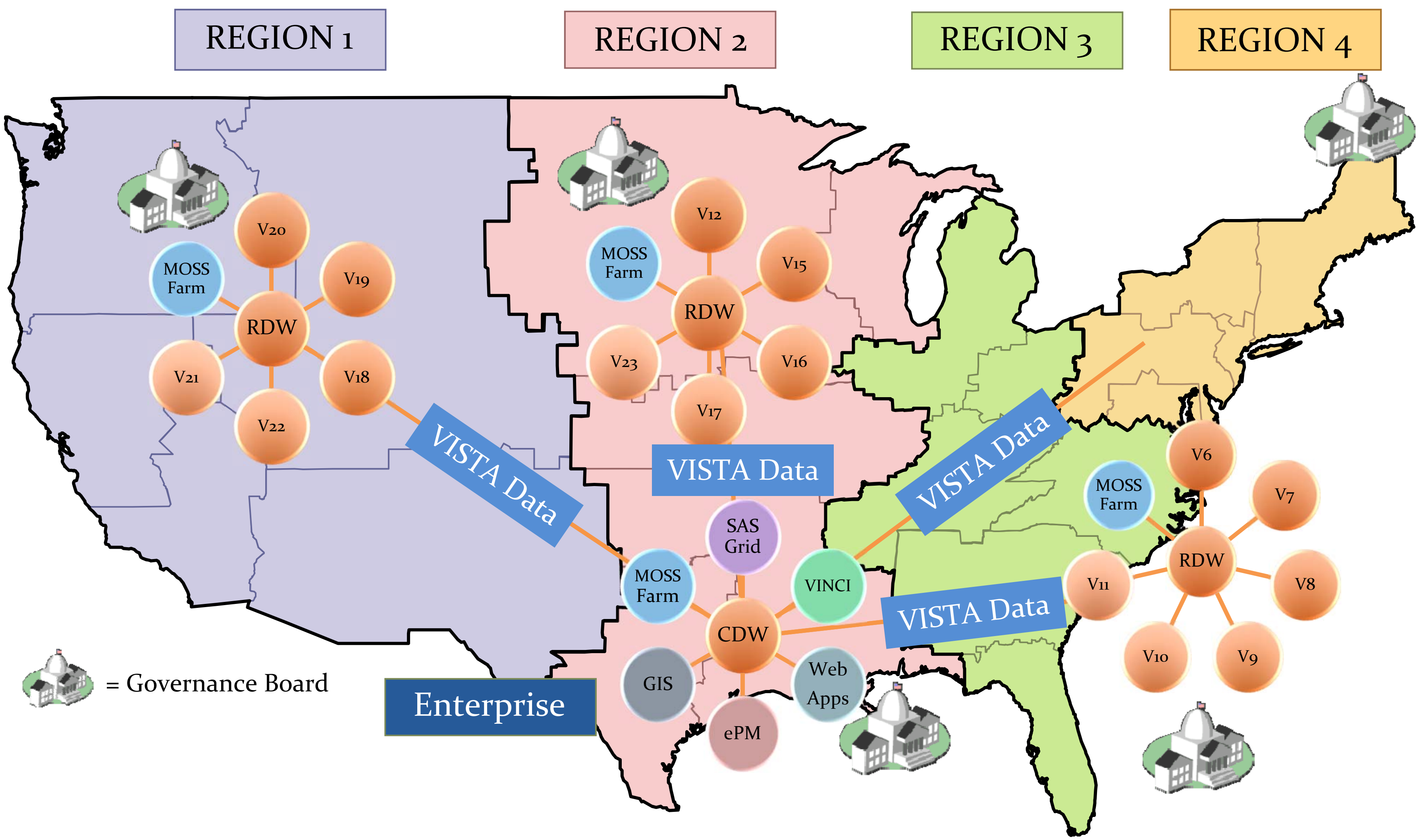
Step two: do temporal analysis– with focus on anomalies

Step three: expert evaluates pattern and determines relevance given objectives

VA telephone encounter data for influenza ICD-9-CM coded calls and emergency department/urgent care visits



Corporate data warehouse



Corporate data warehouse:
unique applications in pharmacy

- Dim.LocalDrug
  - Columns
    - LocalDrugSID (int, not null)
    - LocalDrugIEN (varchar(50), not null)
    - Sta3n (smallint, not null)
    - LocalDrugNameWithDose (varchar(100), null)
    - NonFormularyFlag (char(1), null)
    - InactivationDate (date, null)
    - DEAHandling (varchar(10), null)
    - MaxDosePerDay (varchar(50), null)
    - MaxDosePerDayNumeric (numeric(9,4), null)
    - OrderUnit (varchar(3), null)
    - PricePerOrderUnit (smallmoney, null)
    - DispenseUnitsPerOrderUnit (varchar(20), null)
    - PricePerDispenseUnit (smallmoney, null)
    - CMOPDispenseFlag (char(1), null)
    - VAClassification (varchar(10), null)
    - BestDrugClass (varchar(10), null)
    - NationalDrugIEN (varchar(50), null)
    - NationalDrugSID (int, null)
    - DrugNameWithoutDose (varchar(100), null)
    - ETLBatchID (int, null)
    - VistaCreateDate (datetime, null)
    - VistaEditDate (datetime, null)

Primary Care Team: **All**

Medication Safety

	Actual	Target	Not Met	Patients	Definition
Dashboard Instructions					Definition
Amiodarone	**60.3%**	**62%**		**1,156**	Definition
Amiodarone - LFT < 6 Months	64.9%	68%	406		
Amiodarone - TSH < 6 Months	55.6%	55%	513		
Azathioprine	**69.2%**	**72%**		**164**	Definition
Azathioprine - CBC < 3 Months	60.4%	70%	65		
Azathioprine - LFT < 6 Months	78.0%	76%	36		
Carbamazepine	**68.1%**	**72%**		**689**	Definition
Carbamazepine - CBC < 12 Months	81.3%	85%	129		
Carbamazepine - Level < 6 Months	26.0%	29%	510		
Carbamazepine - LFT < 12 Months	81.6%	86%	127		
Carbamazepine - Sodium < 12 Months	83.5%	88%	114		
Glyburide (65 y/o or older)	**90.2%**	**91%**		**2,681**	Definition
Glyburide - SCr < 2 if at least 65 y/o	90.2%	91%	263		
Leflunomide	**64.8%**	**78%**		**135**	Definition
Leflunomide - CBC < 3 Months	65.9%	79%	46		
Leflunomide - LFT < 3 Months	63.7%	77%	49		
Lithium	**74.3%**	**76%**		**896**	Definition
Lithium - CBC < 12 Months	83.3%	85%	150		
Lithium - Level < 12 Months (at least 900mg/d)	81.7%	87%	99		
Lithium - SCr < 12 Months	89.5%	91%	94		
Lithium - TSH < 6 Months	50.2%	55%	446		
Mercaptopurine	**75.0%**	**84%**		**82**	Definition

Dashboard: primary care

VISN 21 ▸ Clinical Performance Measures

VISN 21 | Clinical Performance ▾ | Finance & Workload ▾ | Medication Safety ▾ | Mental Health ▾ | Pain ▾ | Developers

VISN 21
Clinical Performance
Medication Safety
Finance & Workload
Mental Health
Developers
PBM Contacts

Recycle Bin
All Site Content

If you are having problems viewing this dashboard please Click Here to gain access.

Location and Providers: **VISN 21** Gender: **All** EPRP Eligibility: **Eligible**

Patient Populations

	Patients	Definitions
Diabetes	4,829	Definitions
Ischemic Heart Disease	2,514	Definitions
Hypertension	8,532	Definitions

Patients Requiring Followup

	Patient Report
Upcoming Appointments	Patient Report
Entire Panel	Patient Report
PACT Look-Up	Patient Report
Distance from Medical Center	Patient Report

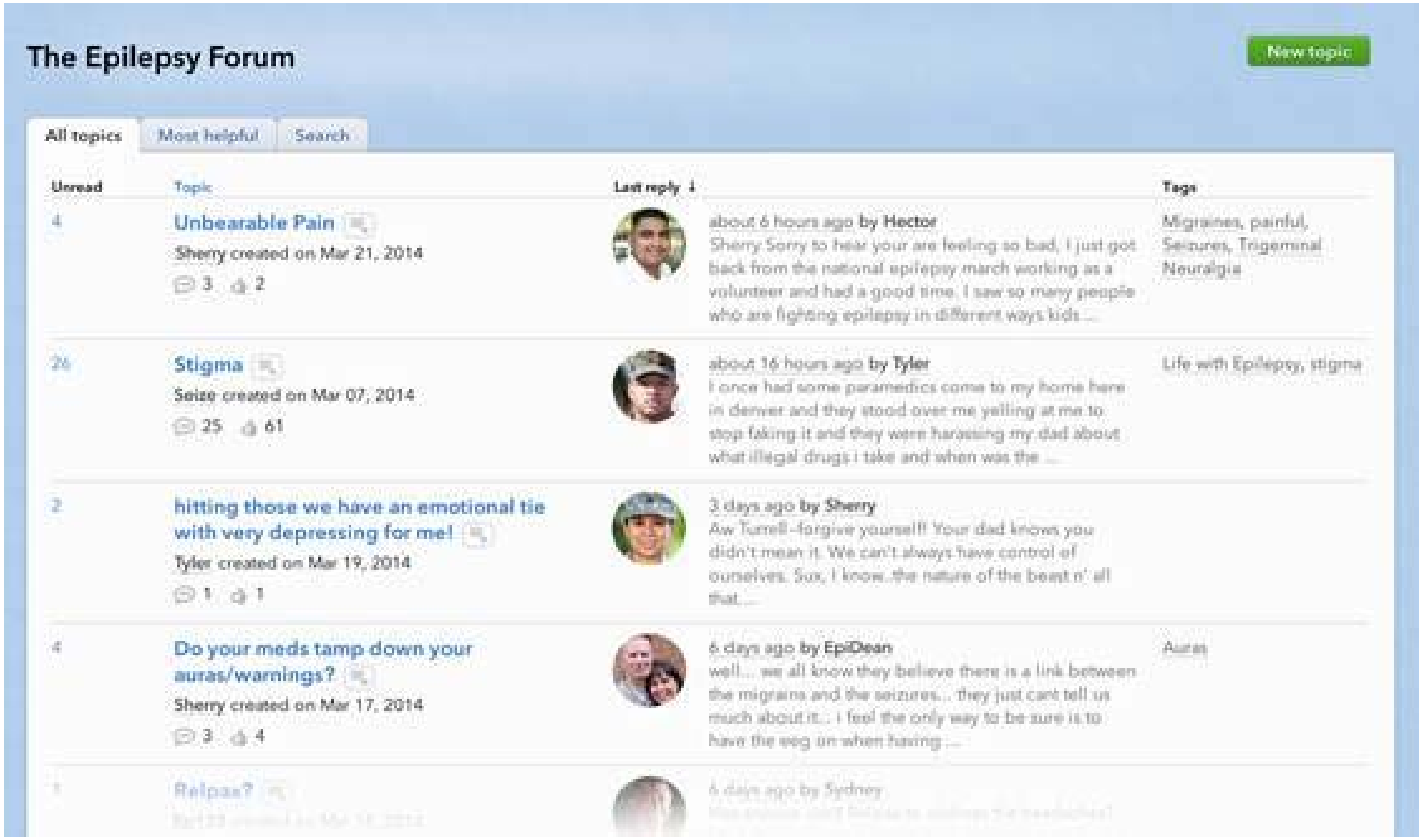
Indicator Key

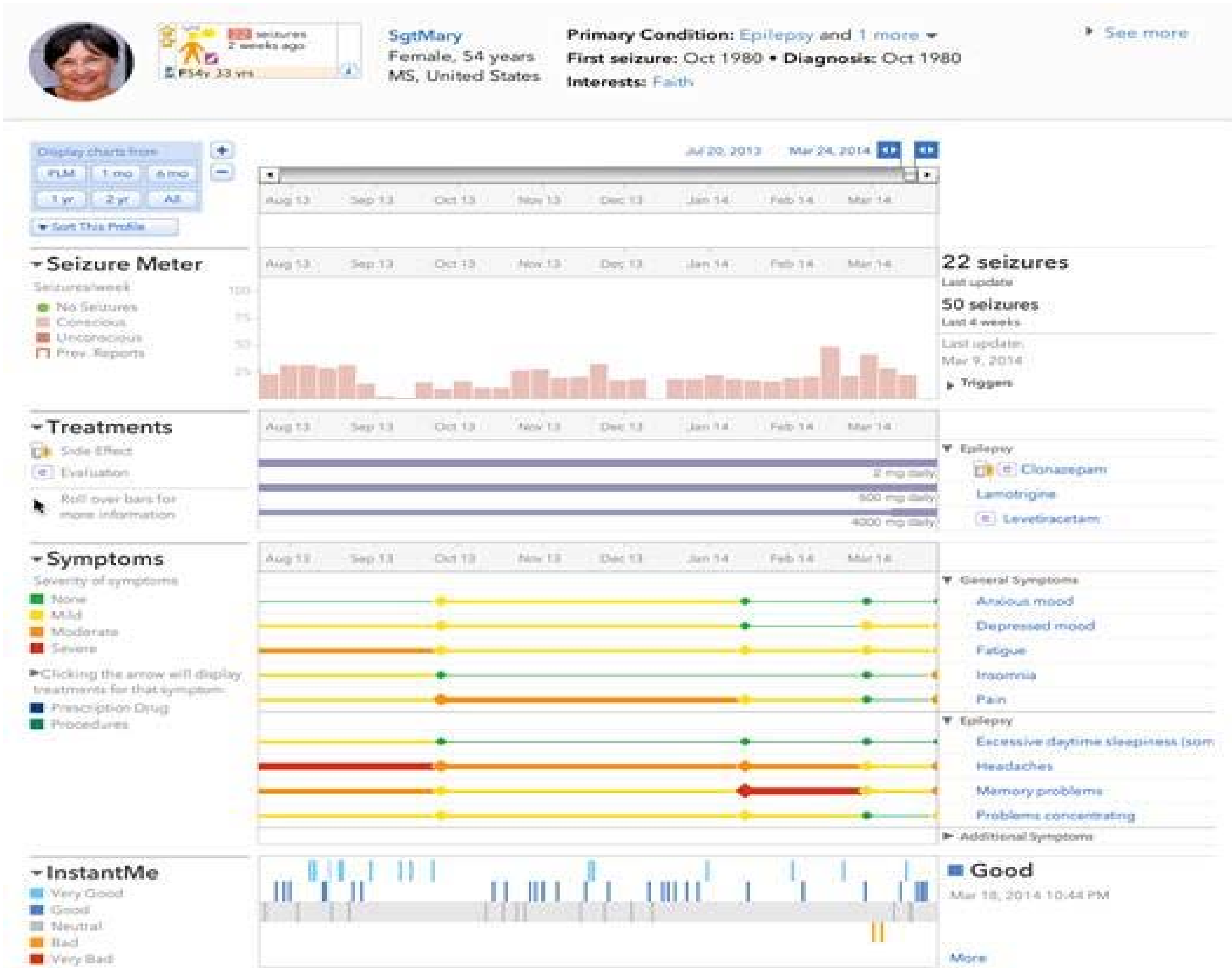
	Target
On Target	●
Slightly Off Target	▲
Off Target	◆

FY11 Performance Measures-DM and IHD

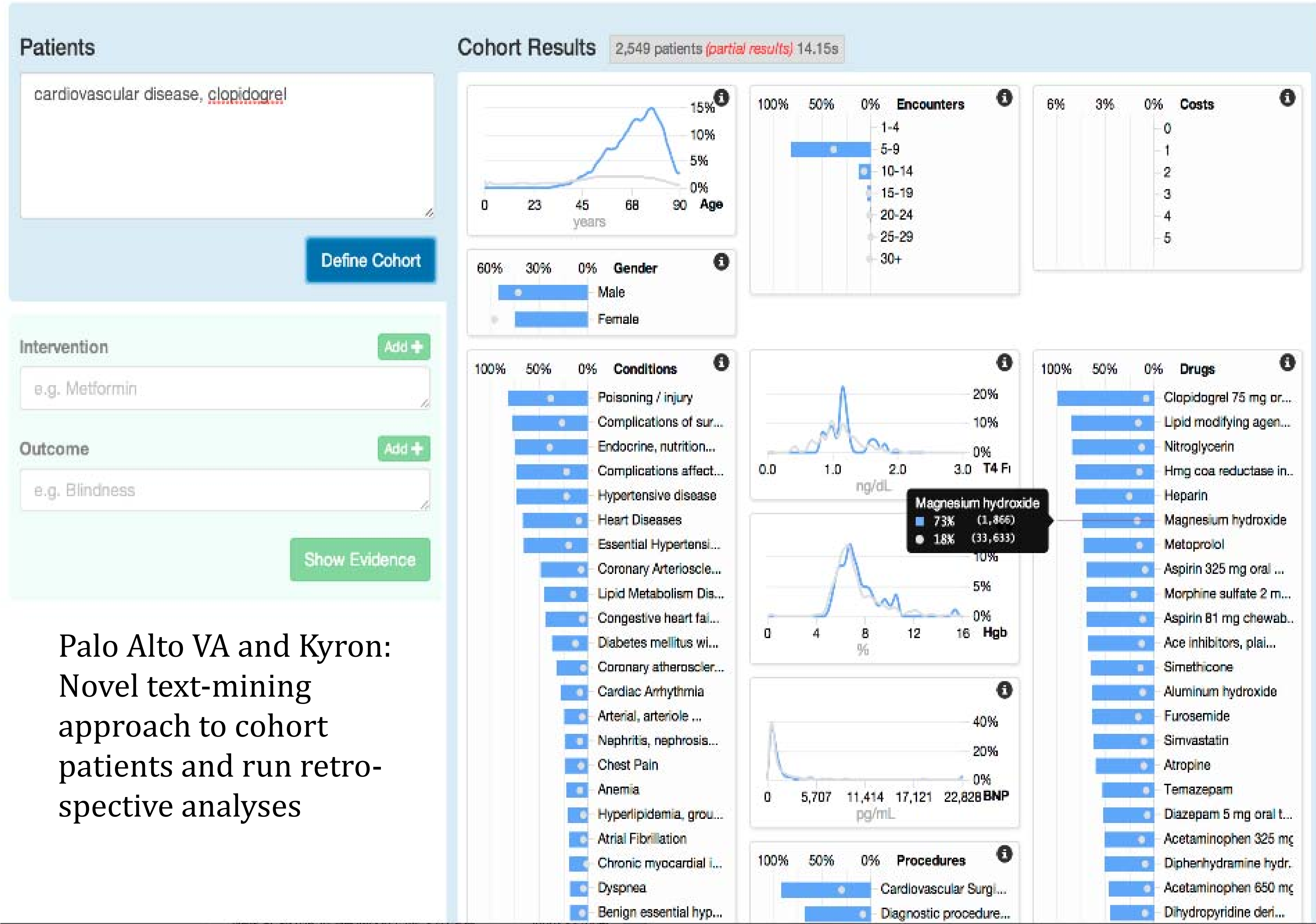
	Actual	Target		Not Met	No Measure	Trends	Definitions
Diabetes Mellitus (Composite)	**88%**	**88%**	●				
Diabetes-Outpt-HBA1C Measured Annually	96.8%	96%	●	154		Trends	Definitions
Diabetes Outpt and HBA1C > 9 (lower is better)	19.5%	19%	▲	790	154	Trends	Definitions
Diabetes Outpt LDL Measured Annually	95.9%	96%	▲	198		Trends	Definitions
Diabetes Outpt and LDL<100	73.1%	75%	▲	1,101	198	Trends	Definitions
Diabetes and BP < 140/90	79.5%	78%	●	894	96	Trends	Definitions
Diabetes Outpt and Timely Retinal Exam	99.8%	99%	●	11		Trends	Definitions
Diabetes Outpt and Renal Function Testing	90.2%	92%	▲	473		Trends	Definitions
Ischemic-Heart-Disease							
IHD - Outpt LDL Measured Annually	94.9%	92%	●	128		Trends	Definitions
IHD - Patients with LDL < 100	74.2%	69%	●	521	128	Trends	Definitions
Hypertension and BP < 140/90	77.3%	72%	●	1,789	152	Trends	Definitions

Patient engagement analytics

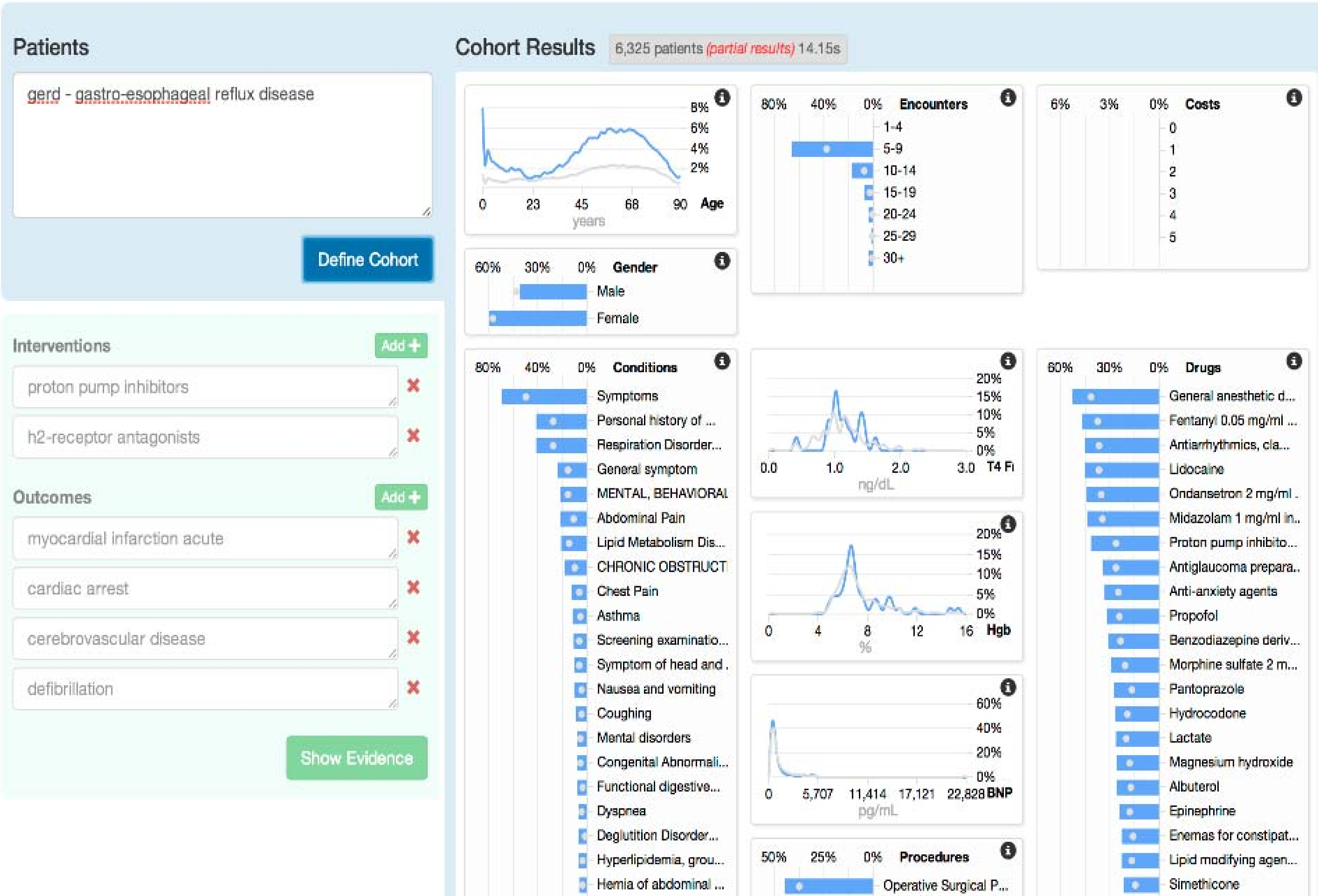


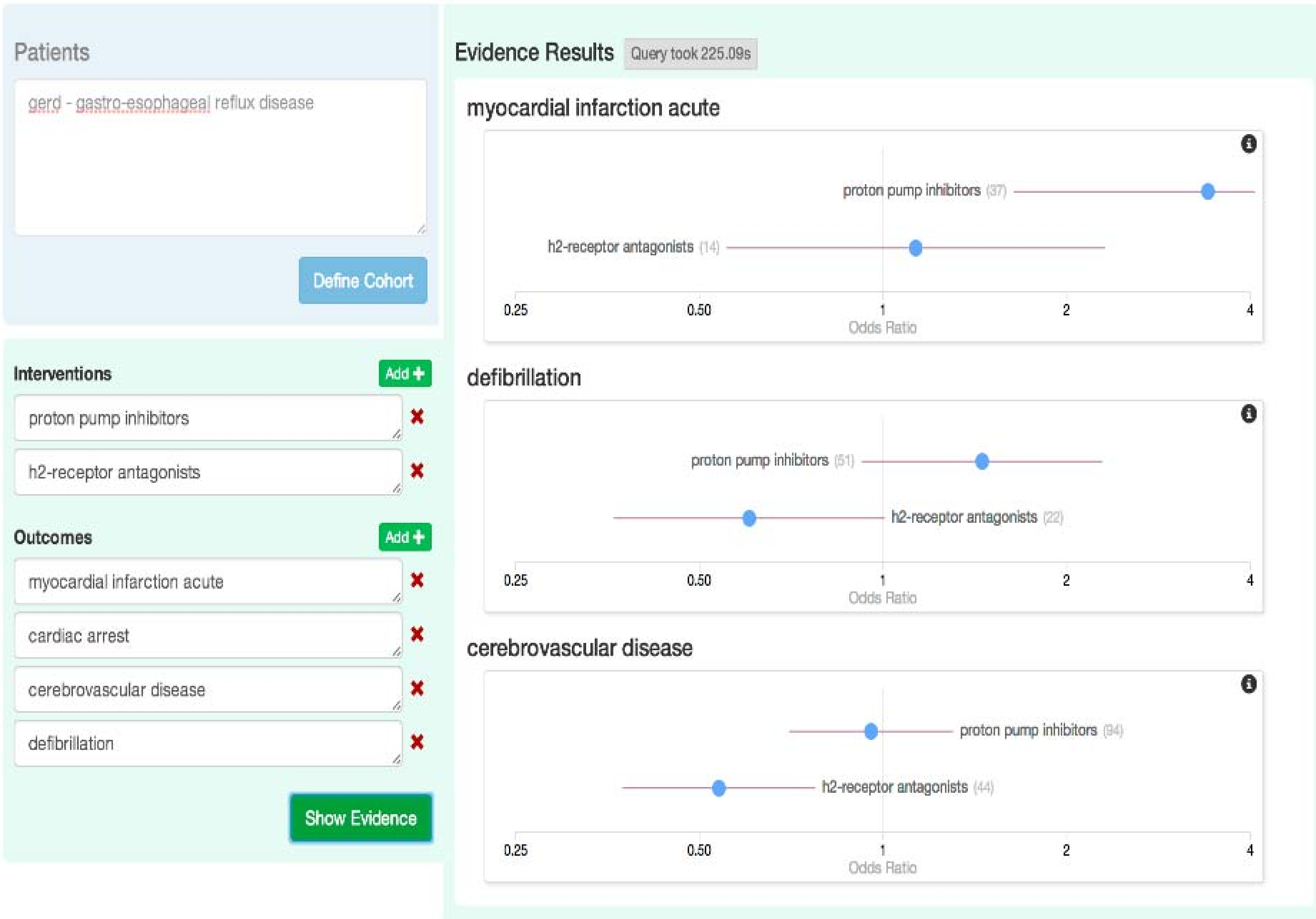


SgtMary
Female, 54 years
MS, United States
Primary Condition: Epilepsy and 1 more
First seizure: Oct 1980 • Diagnosis: Oct 1980
Interests: Faith
See more
Seizure Meter
22 seizures
50 seizures
Last 4 weeks
Treatments
Clonazepam
Lamotrigine
Levetiracetam
Symptoms
General Symptoms
Anxious mood
Depressed mood
Fatigue
Insomnia
Pain
Epilepsy
Headaches
Memory problems
Problems concentrating
InstantMe
Good
More



Palo Alto VA and Kyron: Novel text-mining approach to cohort patients and run retro-spective analyses


Patients
gerd - gastro-esophageal reflux disease
Define Cohort
Interventions
Add +
proton pump inhibitors
h2-receptor antagonists
Outcomes
Add +
myocardial infarction acute
cardiac arrest
cerebrovascular disease
defibrillation
Show Evidence
Cohort Results
6,325 patients (partial results) 14.15s
8%
6%
4%
2%
0
23
45
68
90
Age
years
60%
30%
0%
Gender
Male
Female
80%
40%
0%
Encounters
1-4
5-9
10-14
15-19
20-24
25-29
30+
6%
3%
0%
Costs
0
1
2
3
4
5
80%
40%
0%
Conditions
Symptoms
Personal history of ...
Respiration Disorder...
General symptom
MENTAL, BEHAVIORAL
Abdominal Pain
Lipid Metabolism Dis...
CHRONIC OBSTRUCT
Chest Pain
Asthma
Screening examinatio...
Symptom of head and .
Nausea and vomiting
Coughing
Mental disorders
Congenital Abnormali...
Functional digestive...
Dyspnea
Deglutition Disorder...
Hyperlipidemia, grou...
Hernia of abdominal ...
20%
15%
10%
5%
0%
0.0
1.0
2.0
3.0
T4 Fr
ng/dL
20%
15%
10%
5%
0%
0
4
8
12
16
Hgb
%
60%
40%
20%
0%
0
5,707
11,414
17,121
22,828
BNP
pg/mL
50%
25%
0%
Procedures
Operative Surgical P...
60%
30%
0%
Drugs
General anesthetic d...
Fentanyl 0.05 mg/ml ...
Antiarrhythmics, cla...
Lidocaine
Ondansetron 2 mg/ml .
Midazolam 1 mg/ml in..
Proton pump inhibito...
Antiglaucoma prepara..
Anti-anxiety agents
Propofol
Benzodiazepine deriv...
Morphine sulfate 2 m...
Pantoprazole
Hydrocodone
Lactate
Magnesium hydroxide
Albuterol
Epinephrine
Enemas for constipat...
Lipid modifying agen...
Simethicone


Patients
gerd - gastro-esophageal reflux disease
Define Cohort
Interventions
Add
proton pump inhibitors
h2-receptor antagonists
Outcomes
Add
myocardial infarction acute
cardiac arrest
cerebrovascular disease
defibrillation
Show Evidence
Evidence Results
Query took 225.09s
myocardial infarction acute
proton pump inhibitors (37)
h2-receptor antagonists (14)
0.25
0.50
1
2
4
Odds Ratio
defibrillation
proton pump inhibitors (51)
h2-receptor antagonists (22)
0.25
0.50
1
2
4
Odds Ratio
cerebrovascular disease
proton pump inhibitors (94)
h2-receptor antagonists (44)
0.25
0.50
1
2
4
Odds Ratio

Text Analytics at Stanford Children's Health

Jonathan Palma, MD, MS

AMDIS Physician-Computer Connection Symposium

19 June 2014

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Proofs of Concept

- IBM Content Analytics
  - Watson-like NLP technology
  - Search/analytics application
  - Use case-specific content
- HP Autonomy Healthcare Analytics
  - IDOL statistical inference algorithms
  - Combined with medical terminologies
  - Web-based search application

HP Autonomy Pilot

- Business Owners: Quality and Clinical Effectiveness Team

- Use Case: US News and World Report Survey

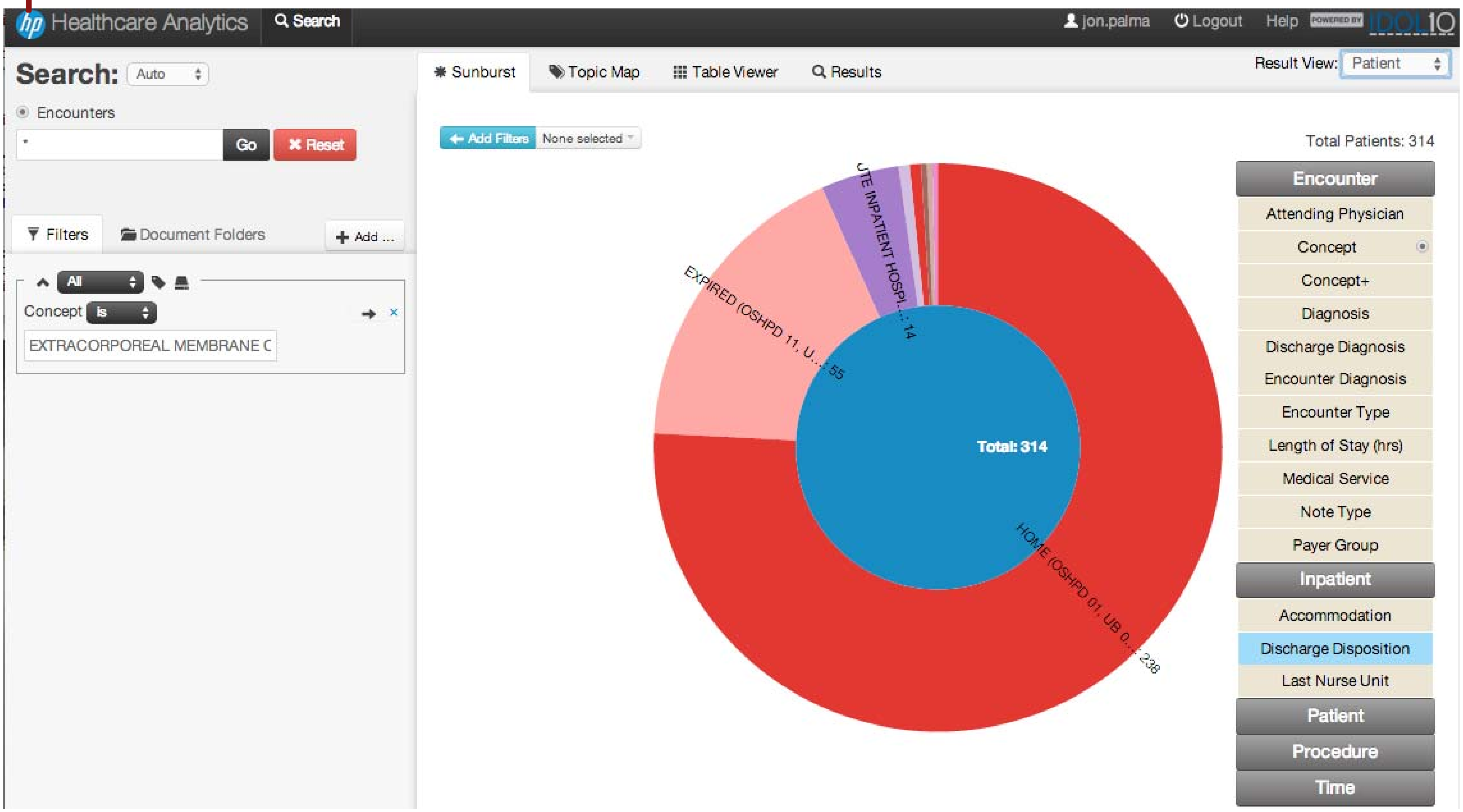
HP Autonomy Pilot

- Clinical data from 2011 – 2013
  - ~115k patients, ~390k encounters, ~3 million documents
- Structured
  - Patient ID, age
  - Encounter ID, location
  - Diagnosis (ICD) and Procedure (CPT) codes
  - Document metadata (e.g. author, attending provider)
- Unstructured
  - Clinical documents
  - Radiology reports

HP Autonomy Healthcare Analytics: Core Functions

- Cohort Identification
- Chart Abstraction
- Advanced Analytics

Concept search (SNOMED) for ECMO patients



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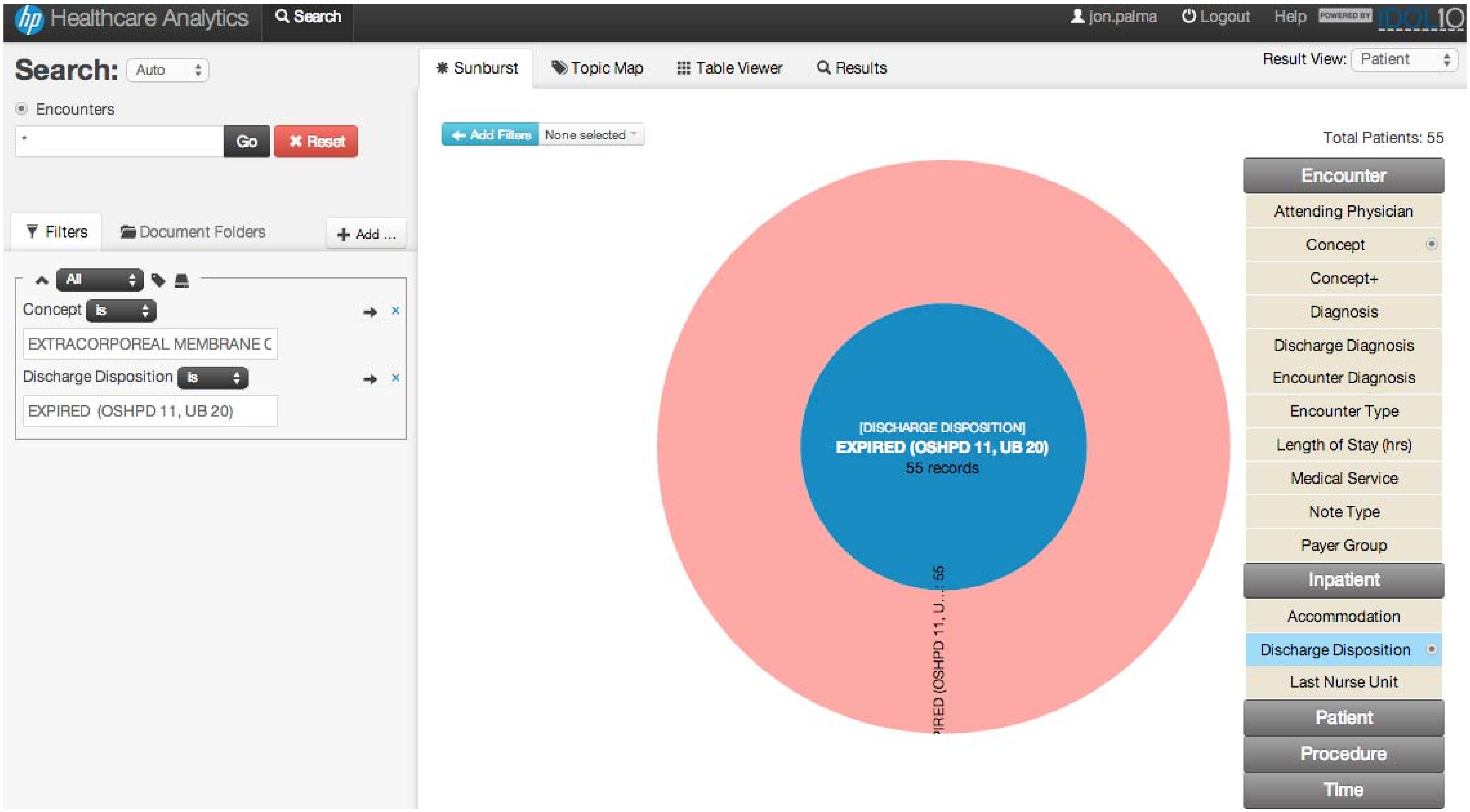
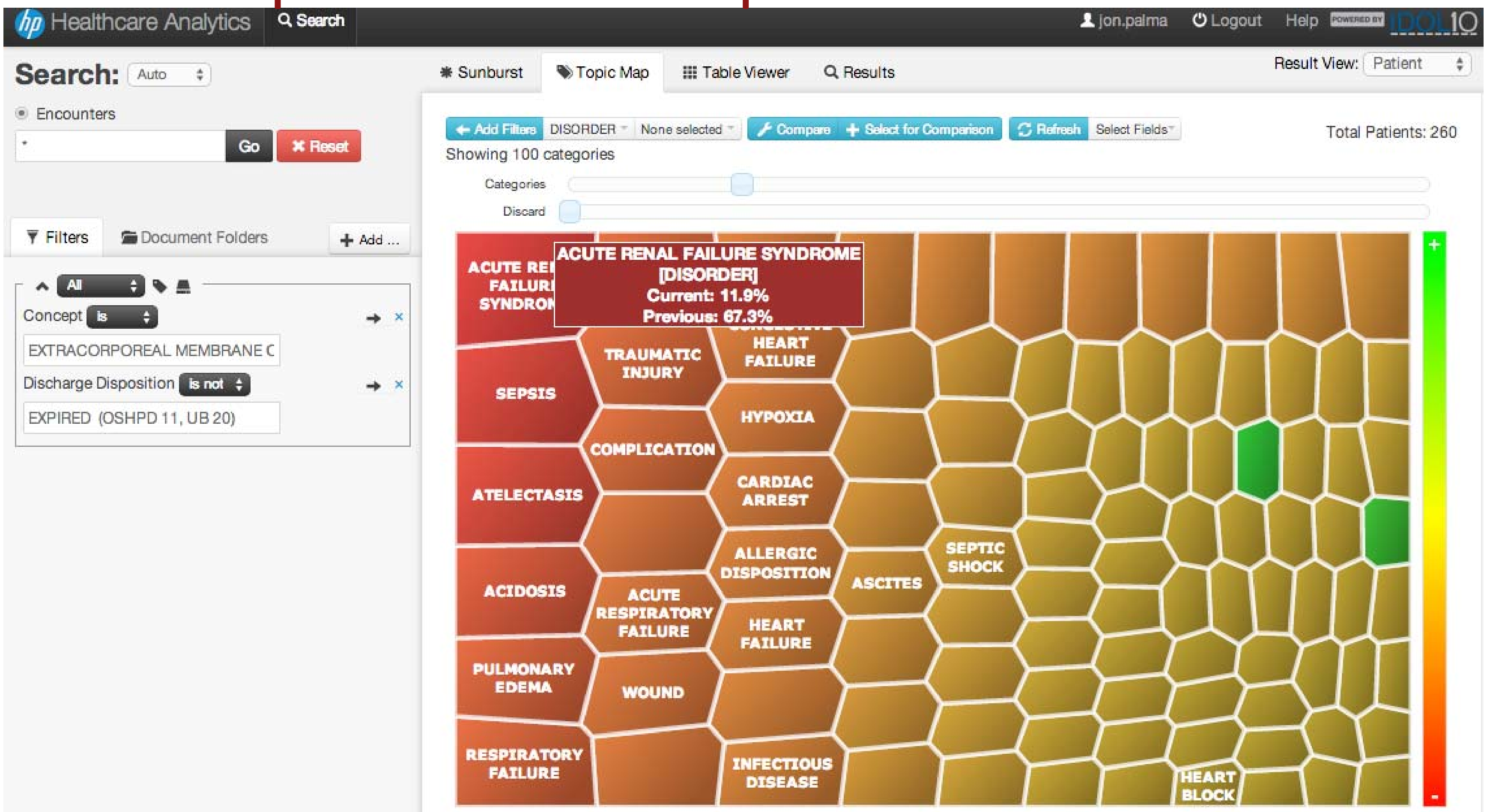
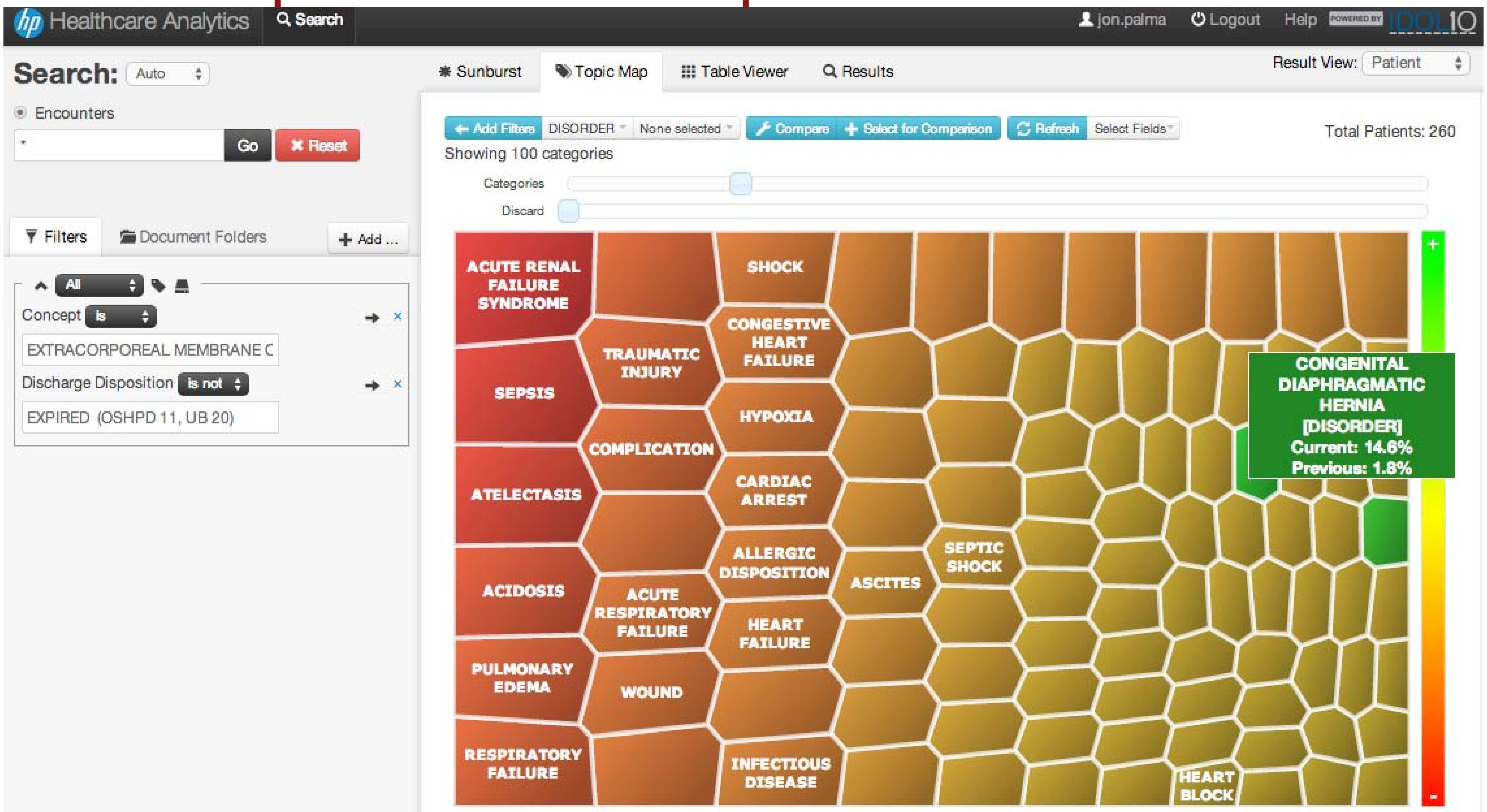
ECMO patients with disposition "Expired"



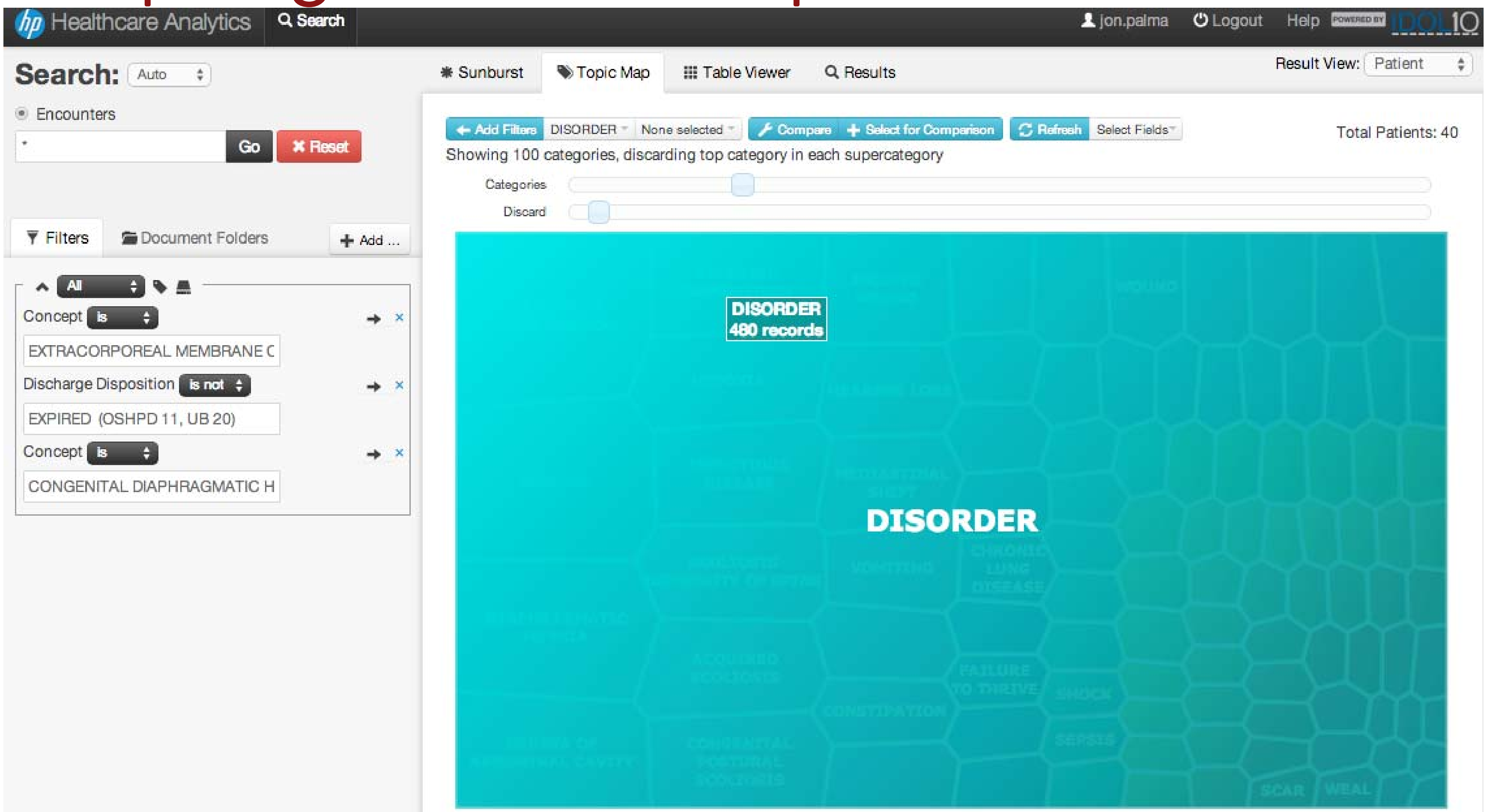
Comparison of Expired vs. non-Expired ECMO patients



Comparison of Expired vs. non-Expired ECMO patients



Additional Filter for Congenital Diaphragmatic Hernia patients



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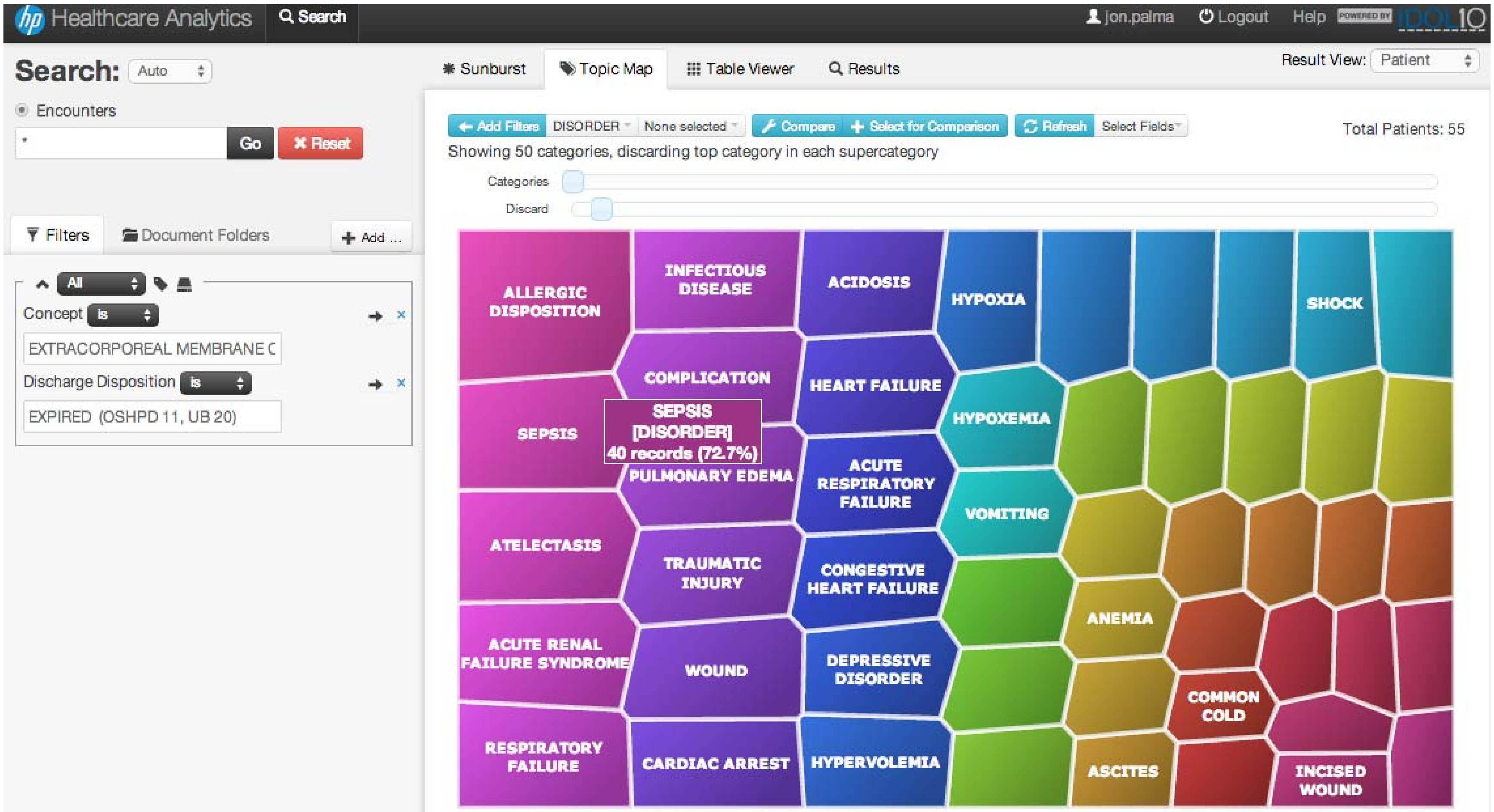
Topic Map of Expired ECMO patients



HP Autonomy Healthcare Analytics: Current Use

- Venous Thromboembolism (Cohort Identification, Chart Abstraction)
- Surgical Site Infections (Cohort Comparison)
- Investigation of other Hospital Acquired Conditions
- Identification of process and outcomes measures
- Development of standardized care protocols

HP Autonomy Healthcare Analytics: Future Directions

- Availability to service chiefs, medical staff
  - Self service analytics tool
  - Security/Privacy considerations
- Facilitate traditional research
- Support the concept of a Learning Healthcare System
  - Insight into past experience (i.e. practice-based evidence)
  - Allow for increasingly data driven care decisions

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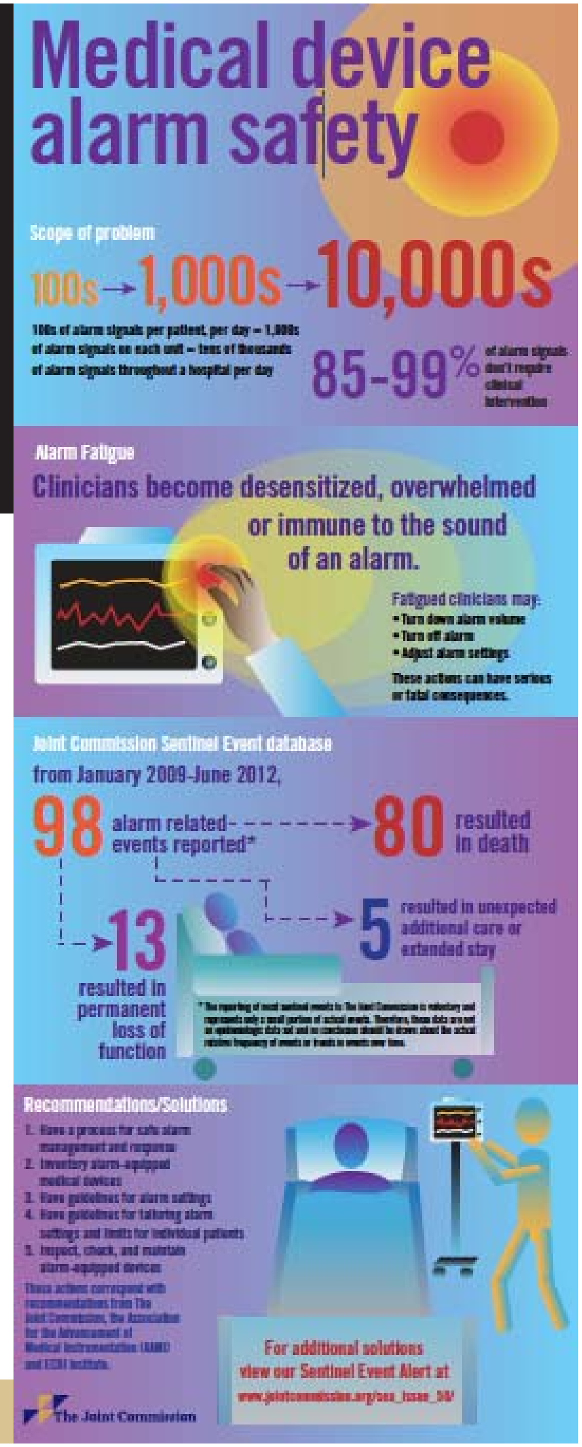
An Application of "Big Data Analytics" at Stanford Children's:
Bedside Monitor Alarm Fatigue

Veena Goel, M.D.
Fellow in Clinical Informatics and Pediatric Hospital Medicine

Stanford Children's Health | Lucile Packard Children's Hospital Stanford

The Joint Commission Sentinel Event Alert



Joint Commission Sentinel Event Alert #50

April 8, 2013

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Medical device alarm safety

Scope of problem

100s → 1,000s → 10,000s

100s of alarm signals per patient, per day = 1,000s of alarm signals on each unit = tens of thousands of alarm signals throughout a hospital per day

85-99% of alarm signals don't require clinical intervention

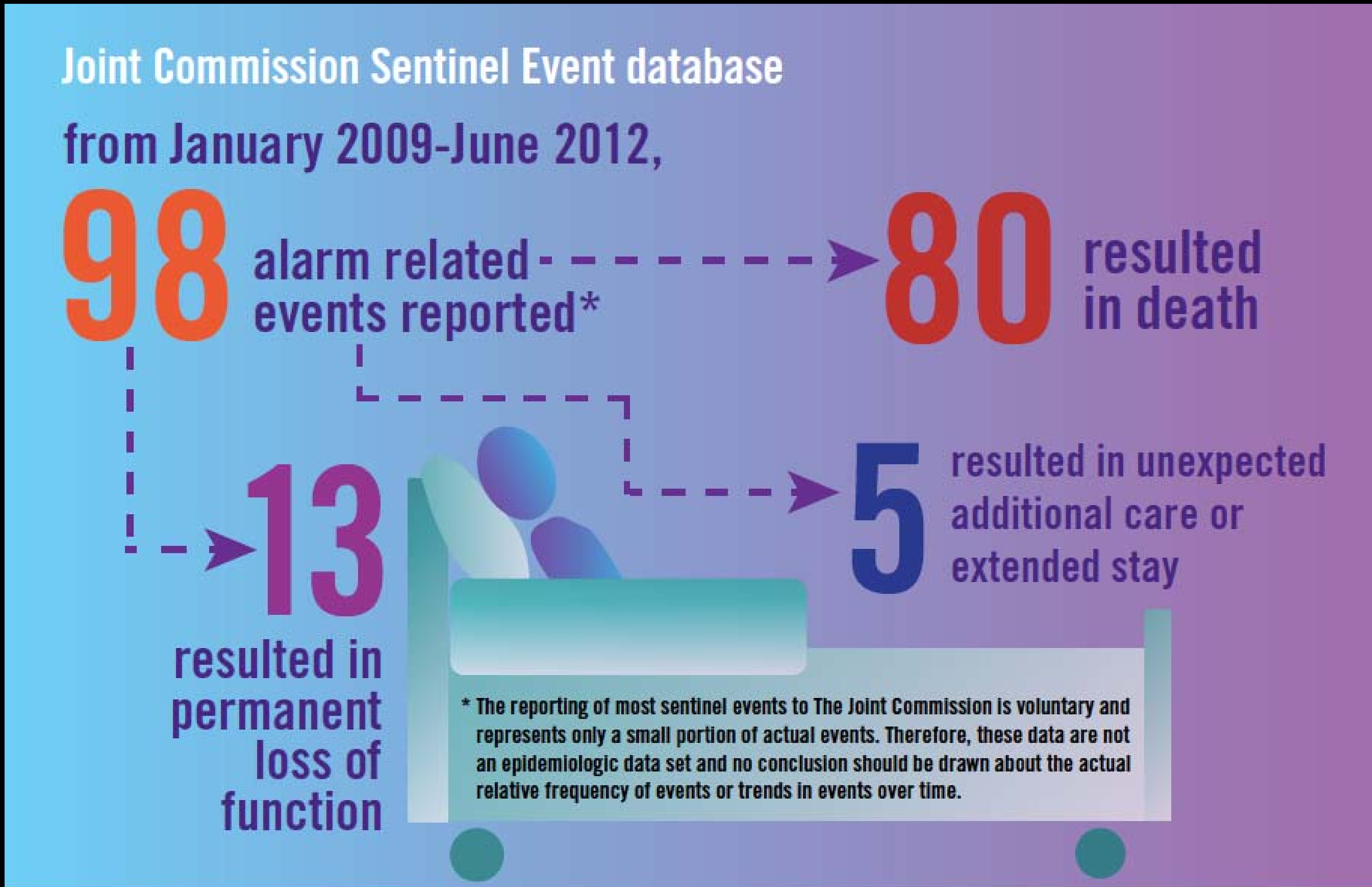
Alarm Fatigue

Clinicians become desensitized, overwhelmed or immune to the sound of an alarm.

Fatigued clinicians may:

- Turn down alarm volume
- Turn off alarm
- Adjust alarm settings

These actions can have serious or fatal consequences.


Joint Commission Sentinel Event database
from January 2009-June 2012,
98 alarm related events reported*
80 resulted in death
13 resulted in permanent loss of function
5 resulted in unexpected additional care or extended stay
* The reporting of most sentinel events to The Joint Commission is voluntary and represents only a small portion of actual events. Therefore, these data are not an epidemiologic data set and no conclusion should be drawn about the actual relative frequency of events or trends in events over time.

Impetus for change

- 2014 National Patient Safety Goal:
  - o Phase 1 (2/2014): alarms to be established as an organization priority by all hospitals.
  - o Phase 2 (2/2016): all hospitals expected to develop and implement specific policies and procedures and to educate organization members about alarm system management.

Recommendations/Solutions

1. Have a process for safe alarm management and response
2. Inventory alarm-equipped medical devices
3. Have guidelines for alarm settings
4. Have guidelines for tailoring alarm settings and limits for individual patients
5. Inspect, check, and maintain alarm-equipped devices

These actions correspond with recommendations from The Joint Commission, the Association for the Advancement of Medical Instrumentation (AAMI) and ECRI Institute.

For additional solutions view our Sentinel Event Alert at

www.jointcommission.org/sea_issue_50/

The Joint Commission

1. Monitor less patients

- Epic EMR roll-out in May 2014
  - Changed patient admission order sets.
  - Unchecked default order to place patients on monitors.
- Working to determine 'best practices' around monitor use.
- Collaboration with and education of nursing management and staff.

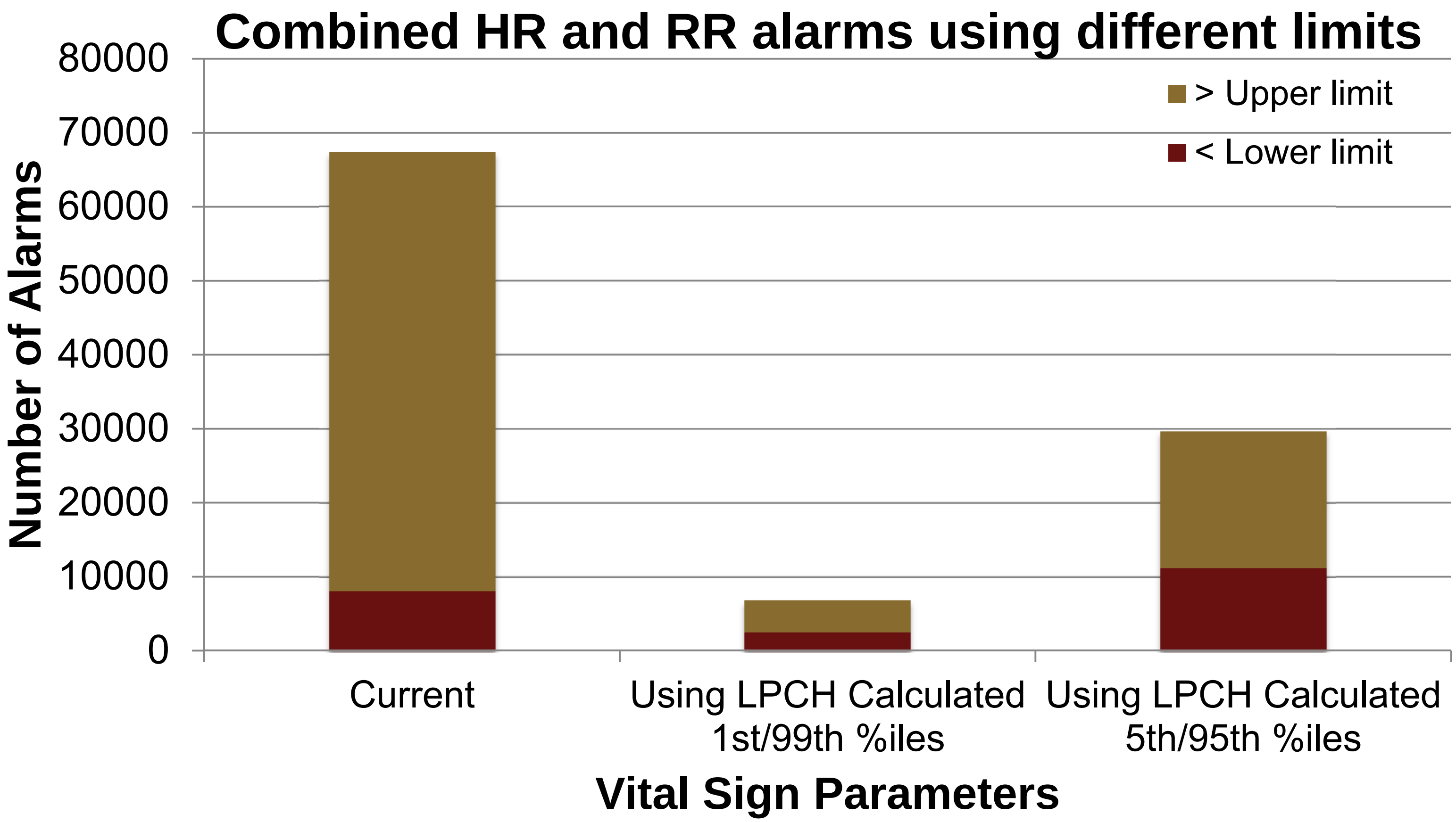
1. Monitor less patients

- Epic EMR roll-out in May 2014
  - Changed patient admission order sets.
  - Unchecked default order to place patients on monitors.
- Working to determine 'best practices' around monitor use.
- Collaboration with and education of nursing management and staff.

2. Data driven vital sign parameters

- Analysis of vital signs of hospitalized patients (stratified by age) in the calendar year 2013 at our institution to create percentile tables for heart rate (HR) and respiratory rate (RR).
- Modeled after work done by Bonafide et. al. (Pediatrics, 2013)
  - Created percentile curves for HR and RR of hospitalized children.
  - Found that 12-54% of HR observations and 32-40% of RR deviated from currently accepted ranges.

Number of out-of-range HR & RR values in 2013 at LPCH



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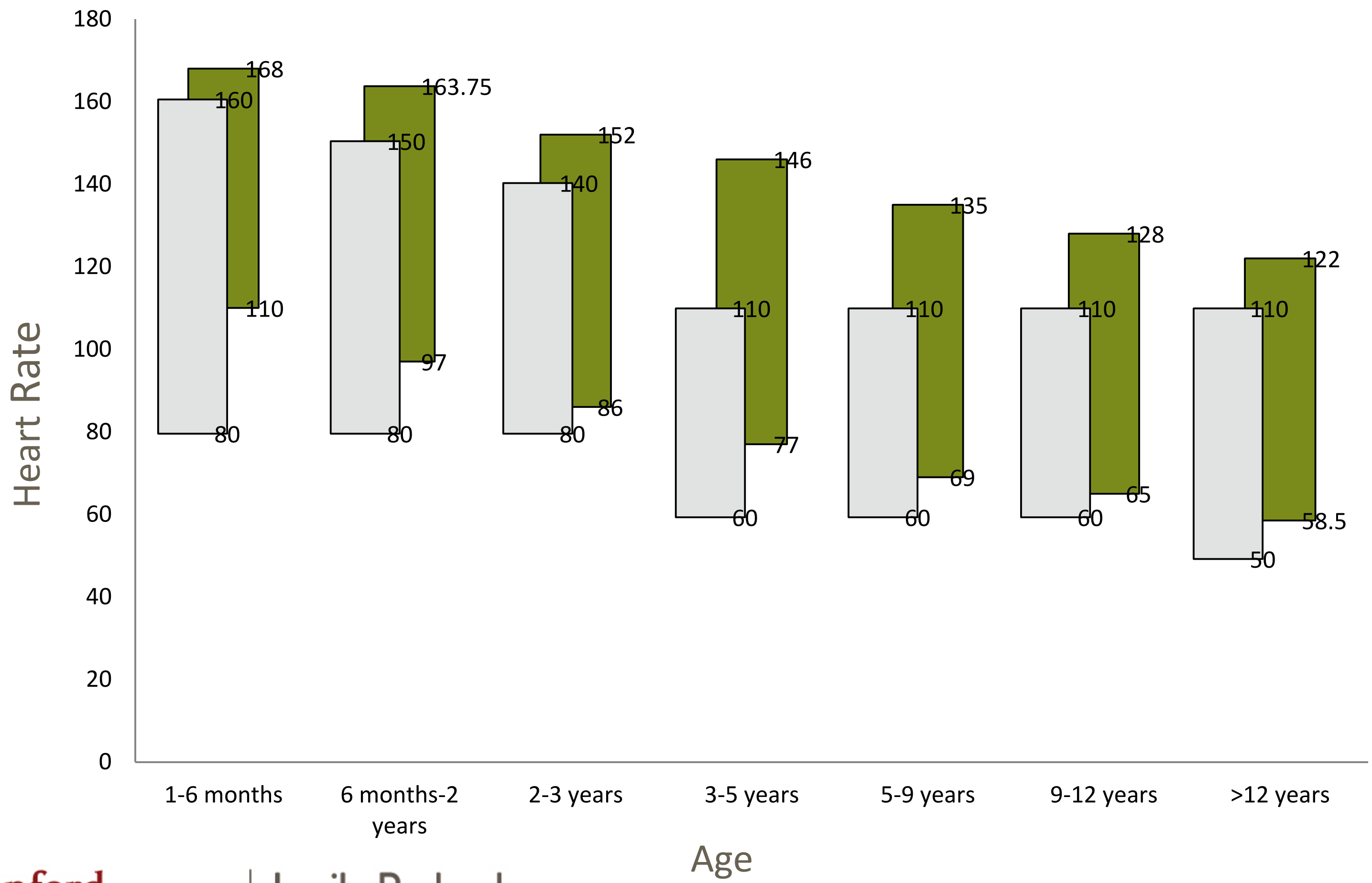
Current vs. Proposed HR parameters by age



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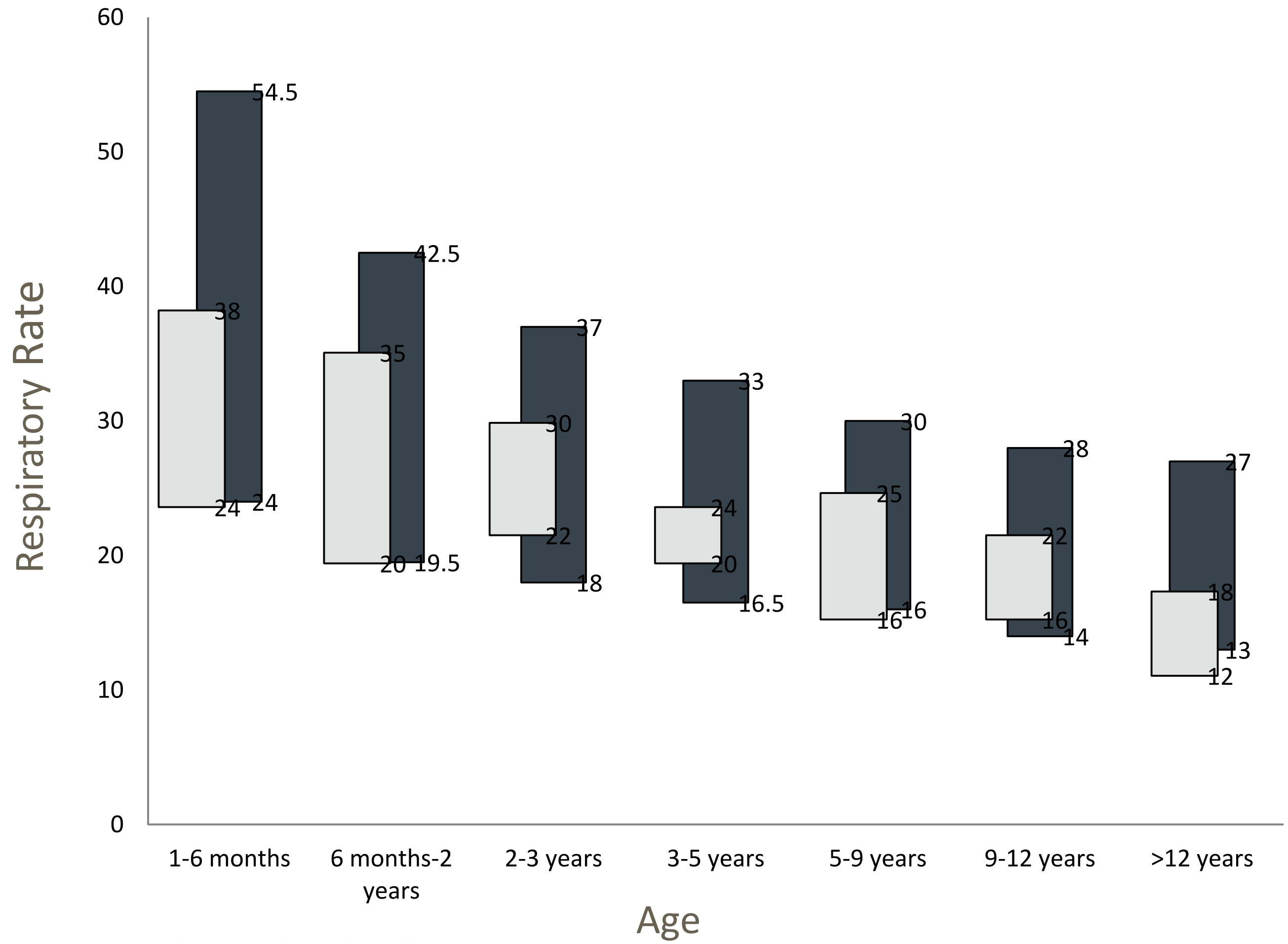
Current vs. Proposed RR parameters by age



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Safety analysis of proposed new vital sign parameters

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- Currently analyzing all rapid-response team calls and patient code events from 2013.
- Goal = to increase specificity of alarms while maintaining sensitivity.

3. Epidemiology of monitor alarms

- Unique data repository containing minute-by-minute monitor alarm and waveform data for all hospitalized patients since 2008.
  - RDE ‘research data export’ program links from the Philips monitors.
- Performing epidemiology analysis of alarms using this database.

Thank you!

Questions/Comments? Please contact me at:

vvgoel@stanford.edu

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CEP Use Case

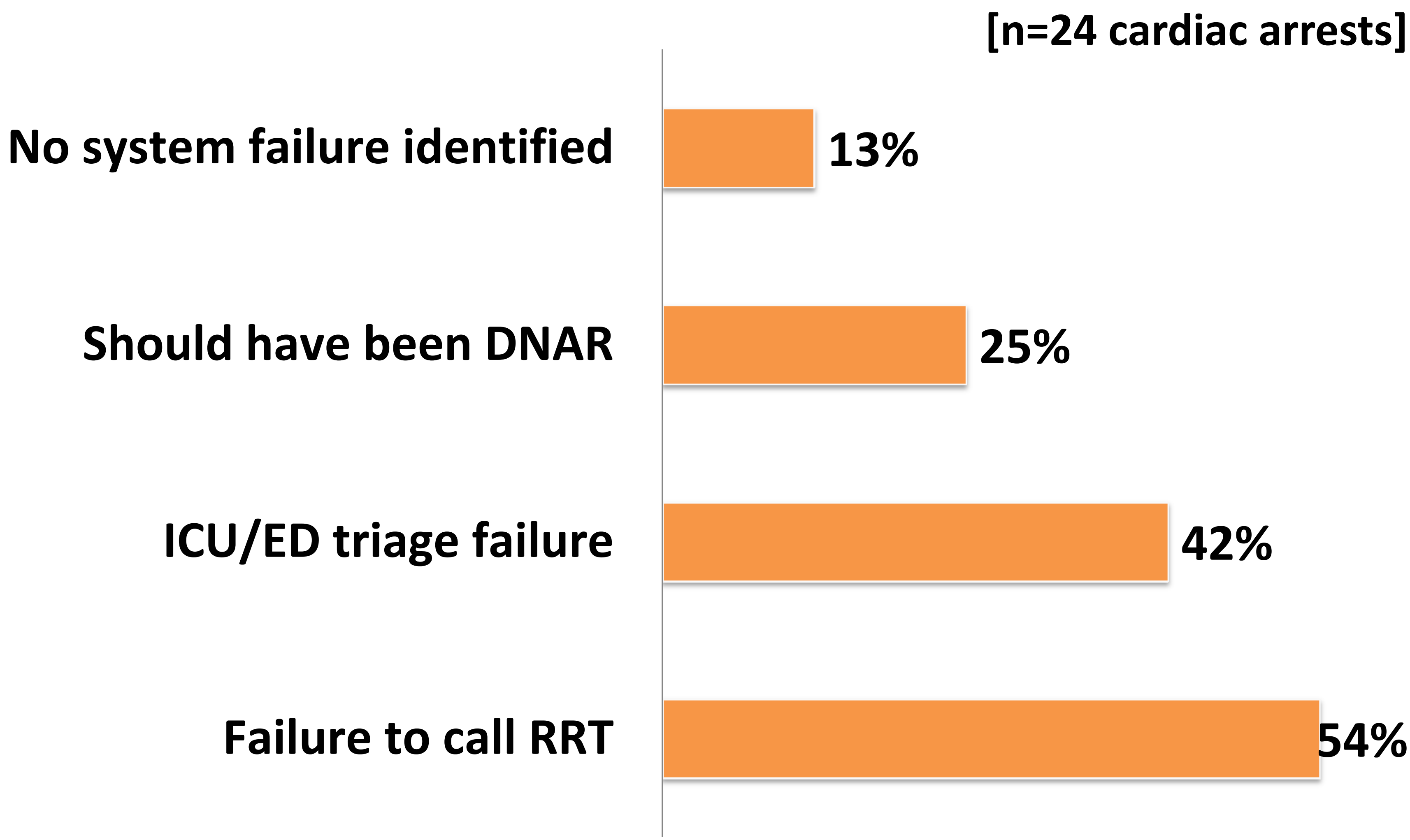
Sameer Badlani, MD, FACP
CMIO
University of Chicago Medicine

Disclosures

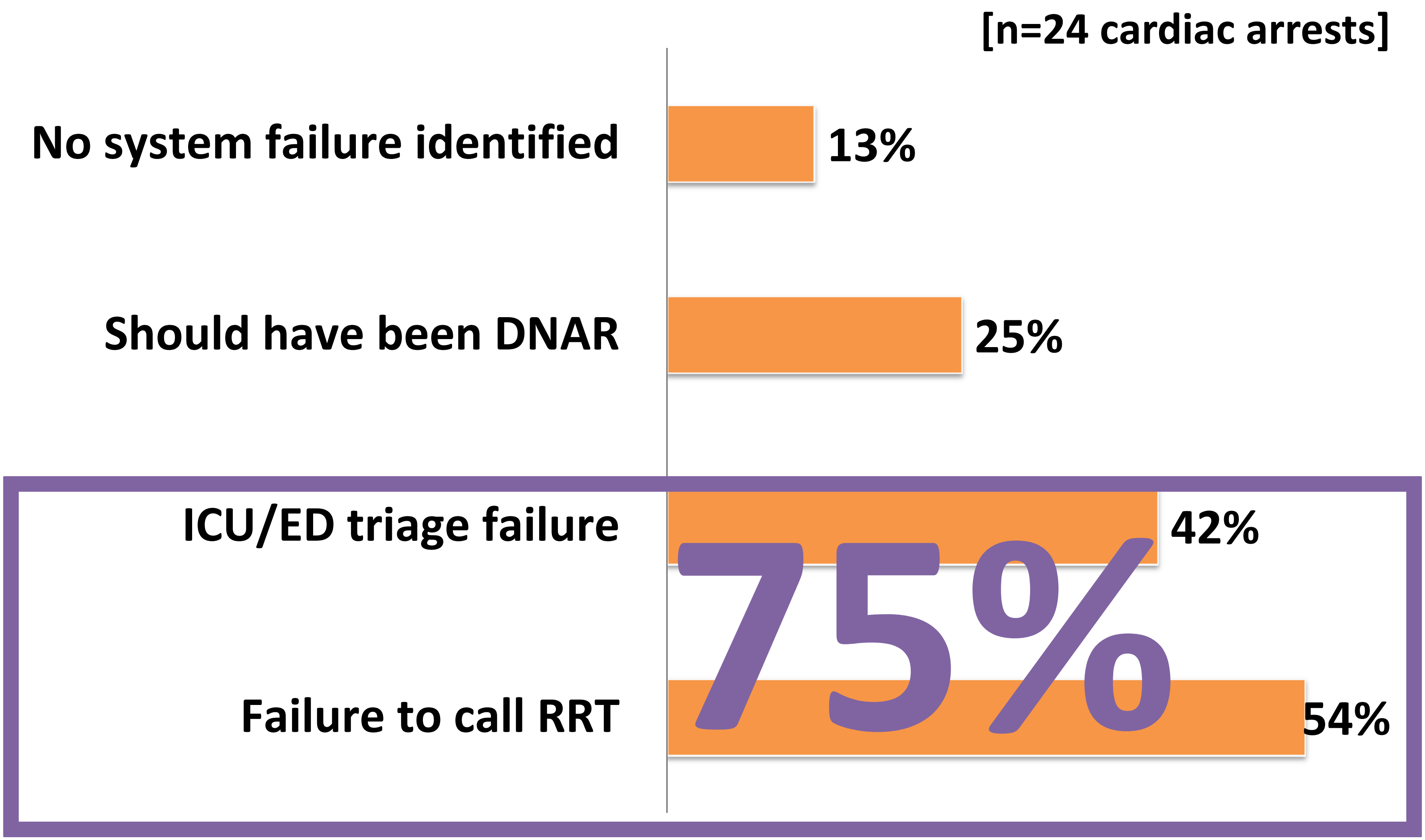
- The eCART algorithm is the intellectual property of the University of Chicago.

- The slides for the Cardiac Arrest algorithm are courtesy Dana Edelson, MD

January-April Ward Case Reviews



January-April Ward Case Reviews



Near Miss Analyis

Prolonged hypotension without RRT activation:

	0828	0830	0831	0835	0850	0900	0915	1000	1015	1030	1045	1100	1131	1145	1200	1215
Temp	35.6 (96...		36.4 (97...					36 (96.8)	35.9 (96...			36.1 (97)	36 (96.8)		36.2 (97...	
Temp Source	Tympanic		Tympanic					Tympanic	Tympanic			Tympanic	Tympanic		Tympanic	
Heart Rate/Pulse	86	88		84	91	85	85	91	96	94	93	88	85	80	77	78
Pulse Method																
Resp	20	22		15	17								20	20		
BP	70/34	70/37		70/35	73/41	72/45	75/43	75/48	82/52	81/41	78/48	85/49	82/43	77/36	83/48	84/46
MAP		45		43	48	52	50	55	60	51	54	58	51	45	56	53
MAP Method	Monitor												Monitor			
BP Method																
Position for BP																
SpO2	99			99	100	100	100						98			

Using Electronic Health Record Data to Develop and Validate a Prediction Model for Adverse Outcomes in the Wards

Matthew M. Churpek, MD, MPH[1,2]; Trevor C. Yuen[1]; Seo Young Park, PhD[3]; Robert Gibbons, PhD[2]; Dana P. Edelson, MD, MS[1]

Objective: Over 200,000 in-hospital cardiac arrests occur in the United States each year and many of these events may be preventable. Current vital sign–based risk scores for ward patients have demonstrated limited accuracy, which leads to missed opportunities to identify those patients most likely to suffer cardiac arrest and inefficient resource utilization. We derived and validated a prediction model for cardiac arrest while treating ICU transfer as a competing risk using electronic health record data.

Design: A retrospective cohort study.

Setting: An academic medical center in the United States with approximately 500 inpatient beds.

Patients: Adult patients hospitalized from November 2008 until August 2011 who had documented ward vital signs.

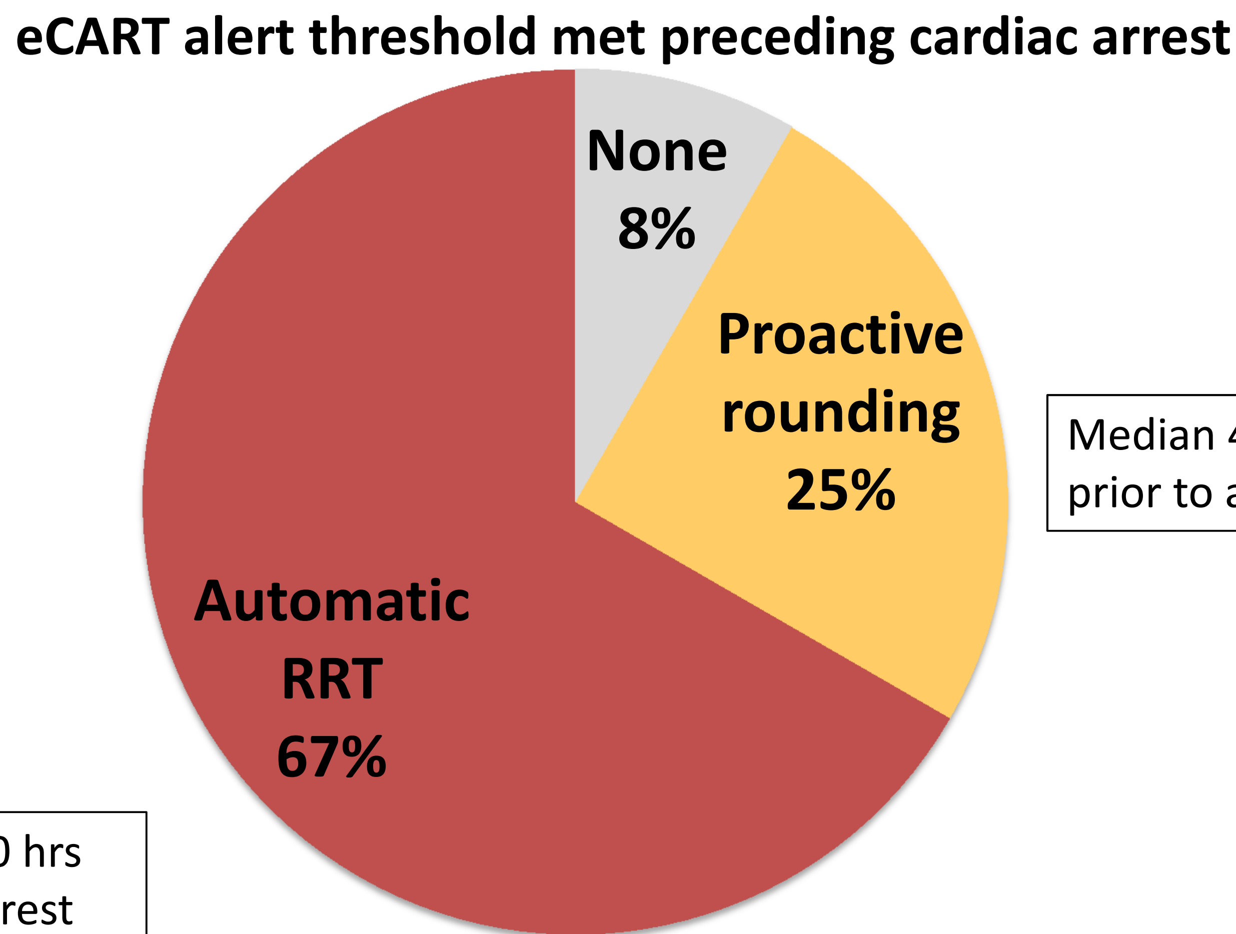
Interventions: None.

Measurements and Main Results: Vital sign, demographic, location, and laboratory data were extracted from the electronic health record and investigated as potential predictor variables. A person-time multinomial logistic regression model was used to simultaneously predict cardiac arrest and ICU transfer. The prediction model was compared to the VitalPAC Early Warning Score using the area under the receiver operating characteristic curve and was validated using three-fold cross-validation. A total of 56,649 controls, 109 cardiac arrest patients, and 2,543 ICU transfers were included. The derived model more accurately detected cardiac arrest (area under the receiver operating characteristic curve, 0.88 vs 0.78; $p < 0.001$) and ICU transfer (area under the receiver operating characteristic curve, 0.77 vs 0.73; $p < 0.001$) than the VitalPAC Early Warning Score, and accuracy was similar with cross-validation. At a specificity of 93%, our model had a higher sensitivity than the VitalPAC Early Warning Score for cardiac arrest patients (65% vs 41%).

Conclusions: We developed and validated a prediction tool for ward patients that can simultaneously predict the risk of cardiac arrest

[1]Department of Medicine, University of Chicago, Chicago, IL.
[2]Department of Health Studies, University of Chicago, Chicago, IL.

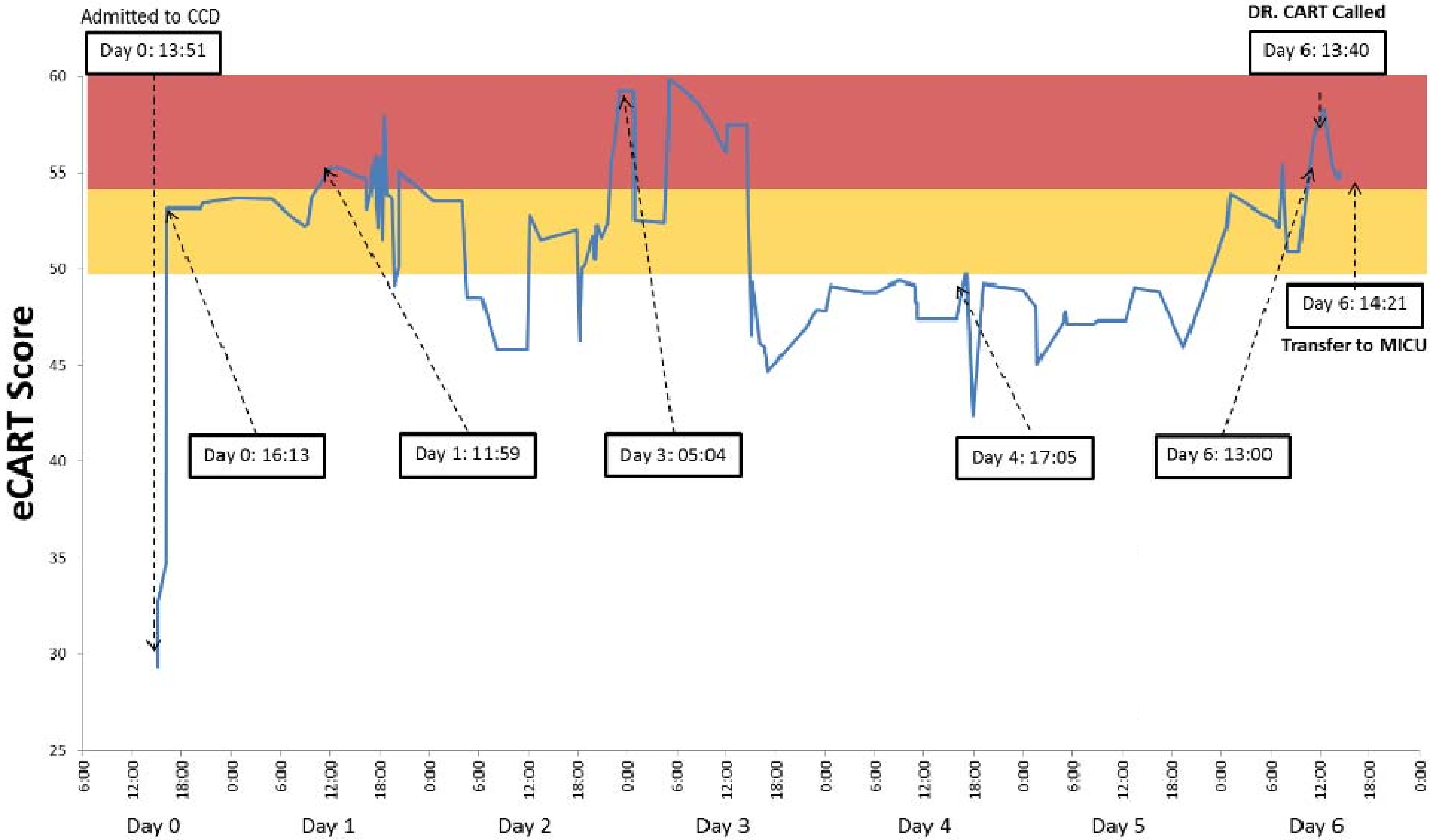
eCART Proof of Concept (Feb 2013 – Apr 2014)



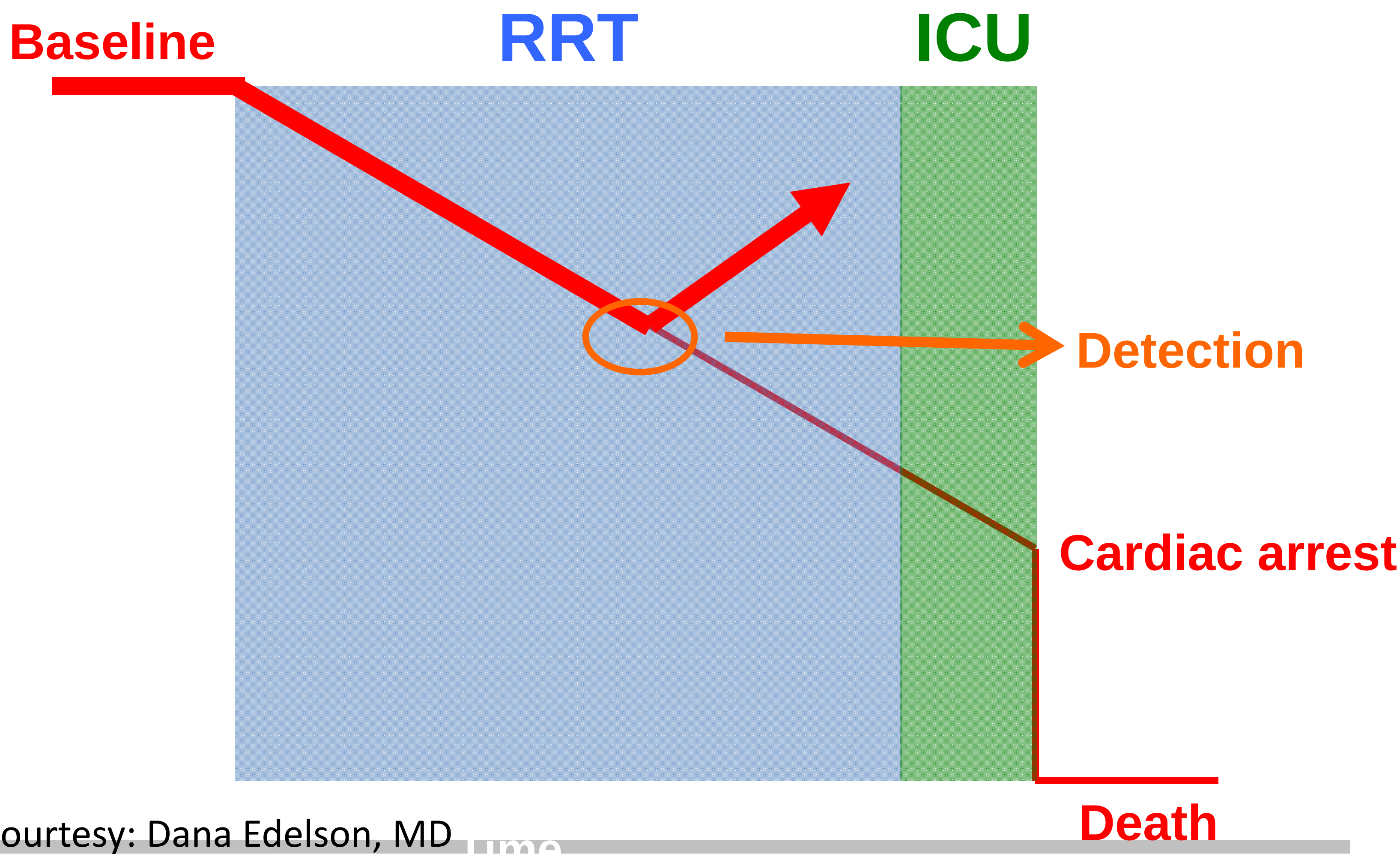
Median 42 hrs prior to arrest

Median 30 hrs prior to arrest

n=12 arrests


Admitted to CCD
Day 0: 13:51
DR. CART Called
Day 6: 13:40
Day 0: 16:13
Day 1: 11:59
Day 3: 05:04
Day 4: 17:05
Day 6: 13:00
Day 6: 14:21
Transfer to MICU
eCART Score
60
55
50
45
40
35
30
25
6:00
12:00
18:00
0:00
Day 0
Day 1
Day 2
Day 3
Day 4
Day 5
Day 6

Accurate detection of cardiac arrest may improve outcomes



Courtesy: Dana Edelson, MD

THE UNIVERSITY OF CHICAGO MEDICINE

Use Case

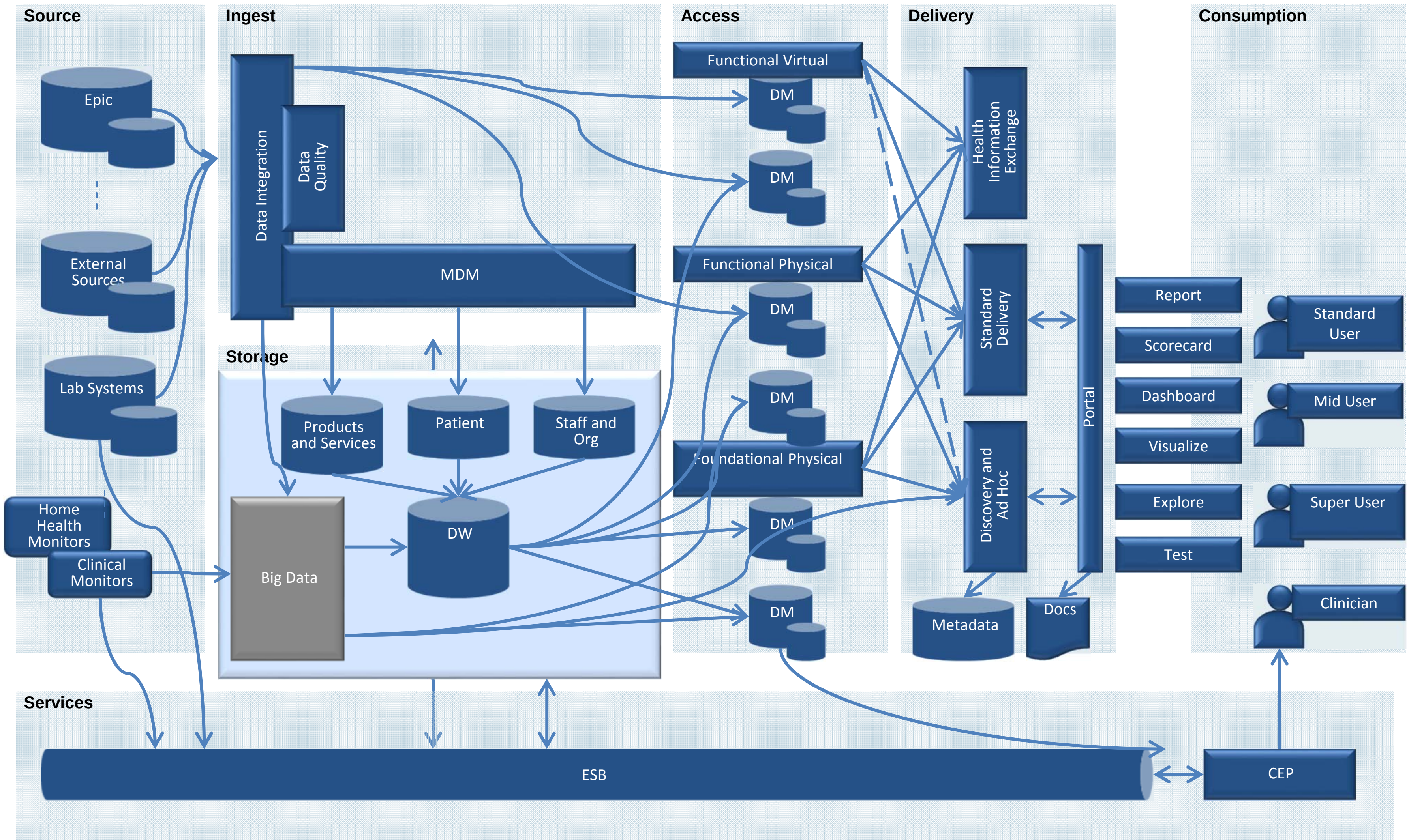
- Problem
  - High rate of inpatient cardiac arrests
  - Unpredictable yet if detected early based on physiological and other signals can lead to improved outcomes
- Data Available but no actionable intelligence
  - Continuous physiological and laboratory monitoring
  - EHR provides easy access but has unmanageable amount of data/information
- Solution
  - Real time statistical model to detect a possible cardiac event
  - Use CEP engine to process information and alert on call physician
  - Suggest actions

Complex Event Processing

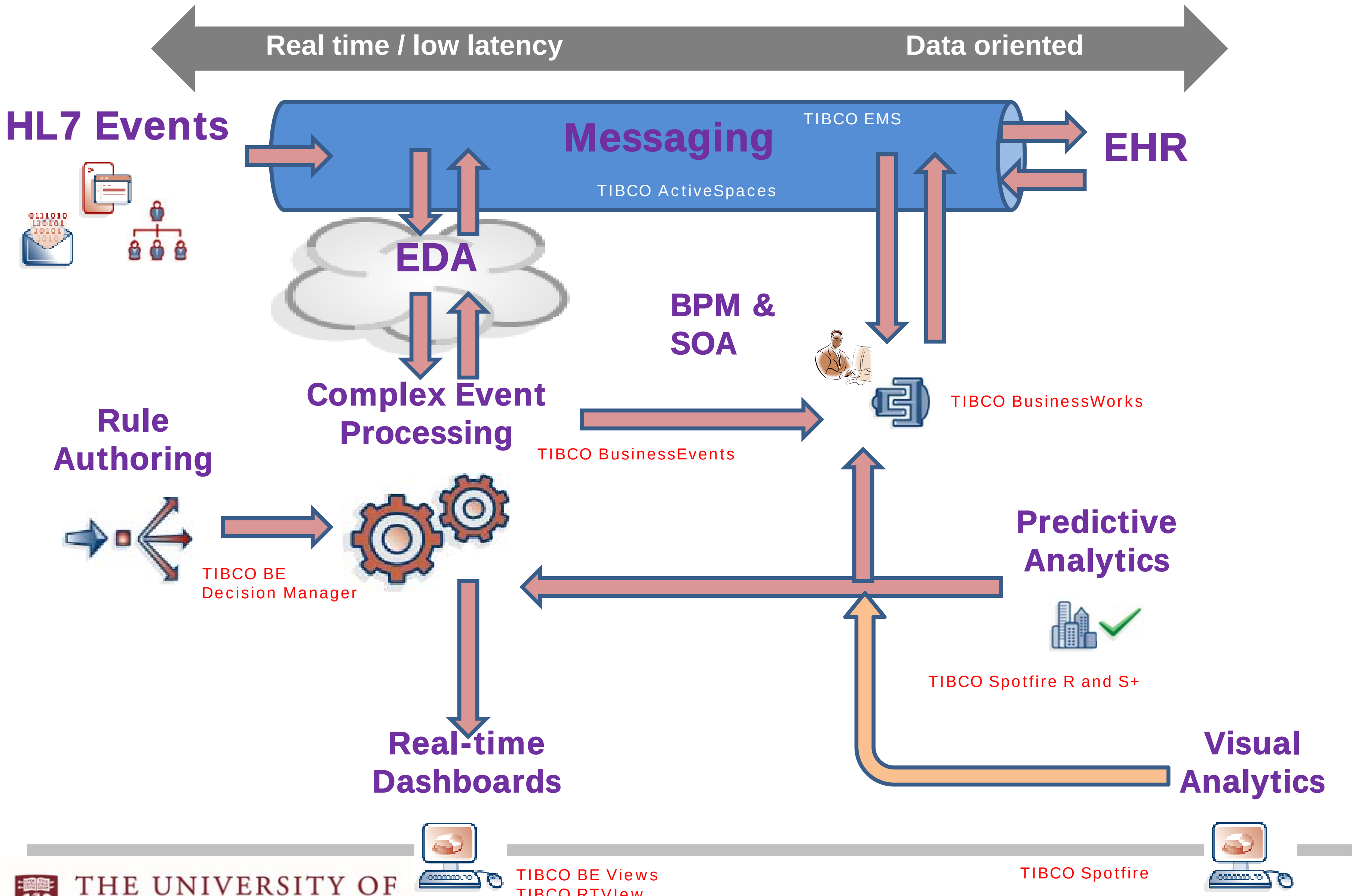
- **Event processing** is a method of tracking and analyzing (processing) streams of information (data) about things that happen (events),[1] and deriving a conclusion from them.
- **Complex event processing**, or CEP, is event processing that combines data from multiple sources[2] to infer events or patterns that suggest more complicated circumstances. The goal of complex event processing is to identify meaningful events (such as opportunities or threats)[3] and respond to them as quickly as possible.

- Source : Wikipedia

UCM Architecture Target State



Service Oriented Architecture and Complex Event Processor



Questions

sbadlani@medicine.bsd.uchicago.edu

A Green Button?

My Patient

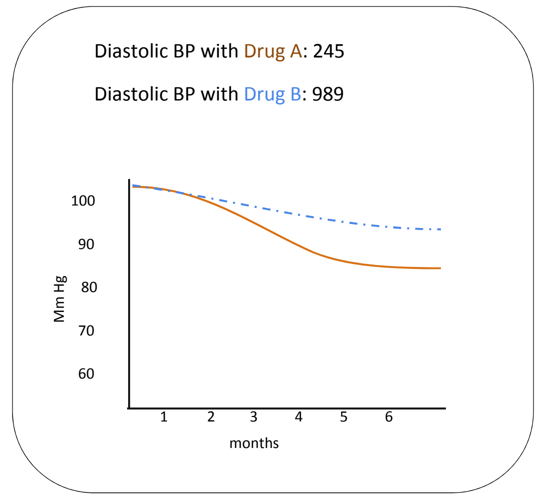
A 55 year old female of Vietnamese heritage with known asthma presents to her physician with new onset moderate hypertension

Intervention

antihypertensives

Outcome

Diastolic pressure < 90 mm Hg



Longhurst et al. A ‘Green Button’ For Using Aggregate Patient Data At The Point Of Care. *Health Affairs*, July 2014.

Analytics Panel

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- Sarah Russell, MD, MBA
  Palo Alto, CA
  sarah.russell@va.gov
- Jon Palma, MD, MS and Veena Goel, MD
  Stanford, CA
  jpalma@stanfordchildrens.org and vgoel@stanford.edu
- Sameer Badlani, MD
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