HUMEDICA
Defining Knowledge.

Achieving Value from Diverse Healthcare Data

Paul Bleicher, MD, PhD
Chief Medical Officer
Humedica
Boston MA

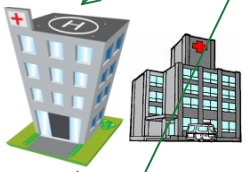
The Information Environment in Healthcare

Hospitals

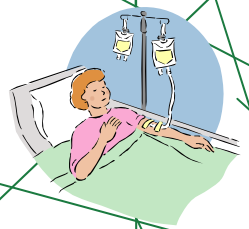
Physicians

Pharmacies and PBMs

Pharma, Biotech, Devices



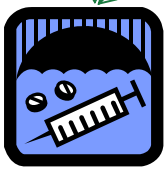
IDNs



Patients

Group Clinics

Payors



Labs

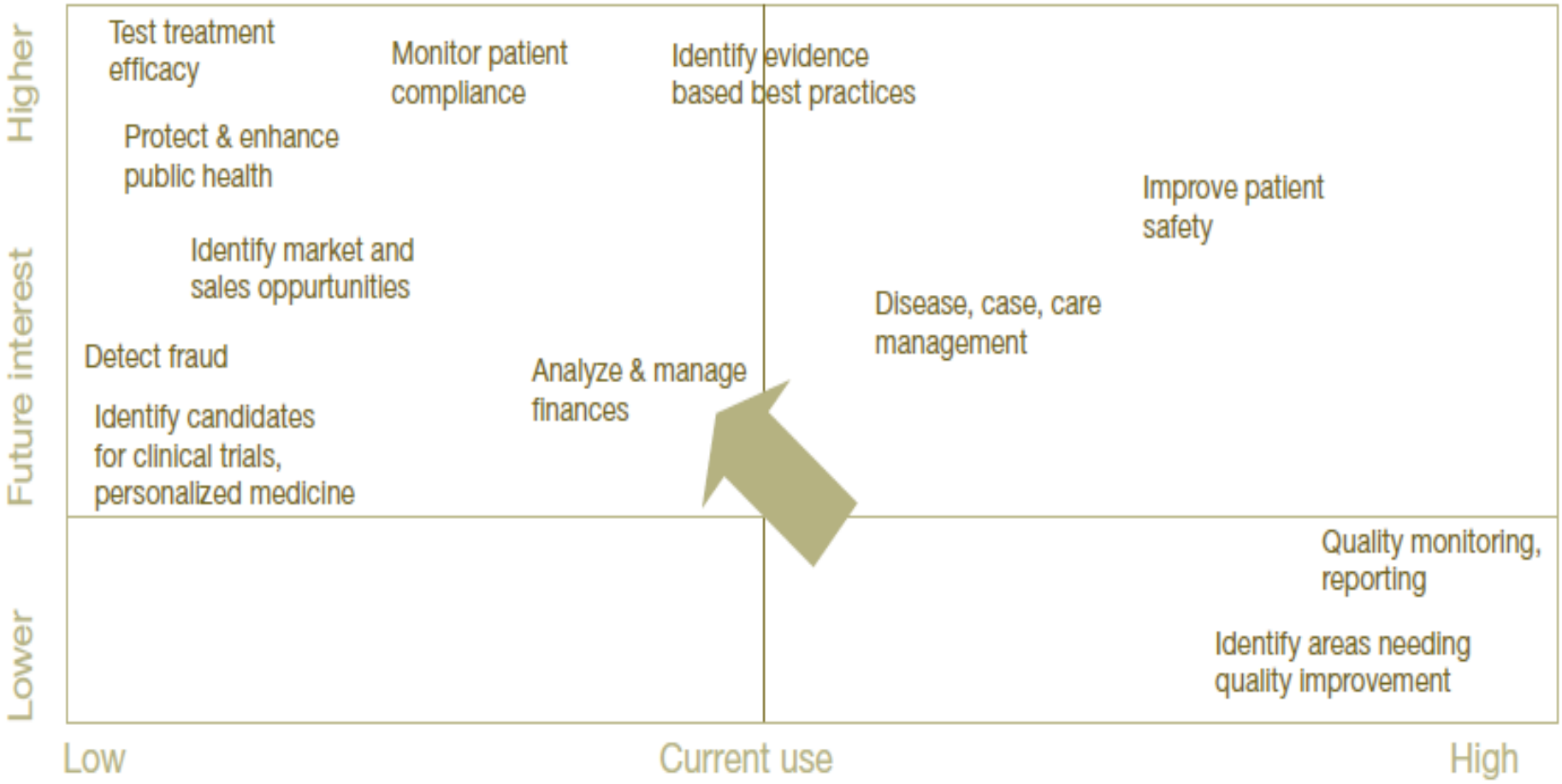
External Data Sources
Eg. Census

Government

Health Care Applications Requiring Data

- Quality Management
  - Outcomes
  - Staffing and Resources
  - Physician and care team accountability
  - Accreditation and Pay for Performance
    - JCAHO, PQRI, HEDIS, etc.
  - Compliance with care maps, order sets, etc.
- Patient Safety
  - Risk profiles
  - Medication and procedural errors
  - Sentinel events
- Resource and Cost Analysis
- Research and Hypothesis Generation

Healthcare Needs for Electronic Data

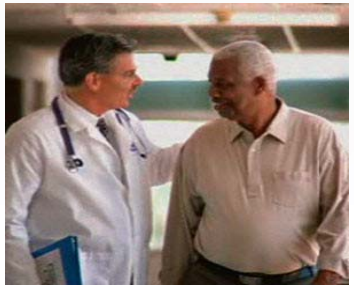


Source: PricewaterhouseCoopers survey. http://www.pwc.com/us/en/healthcare/publications/secondary-health-data.jhtml

True Longitudinal Patient Records

Patient Encounter

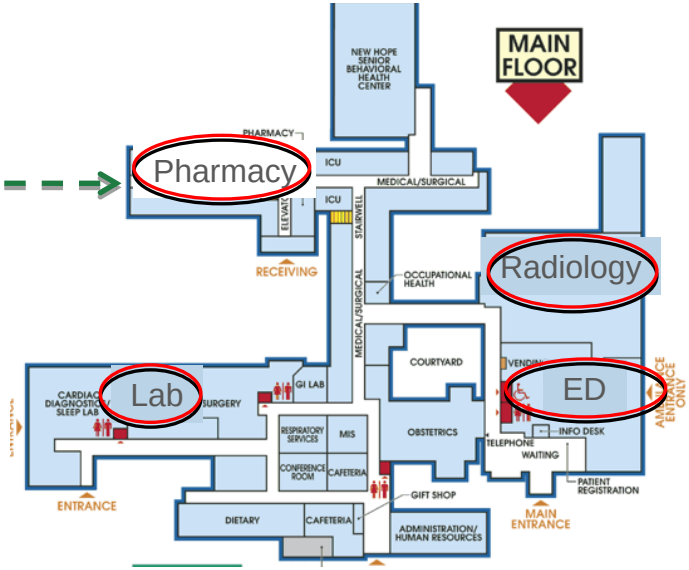
- Complaints
- Symptoms
- Diagnosis
- Vital Signs
- Physician Notes
- Lab & Radiology Reports



Outpatient

Treatment triggers, therapeutic choices and associated outcomes

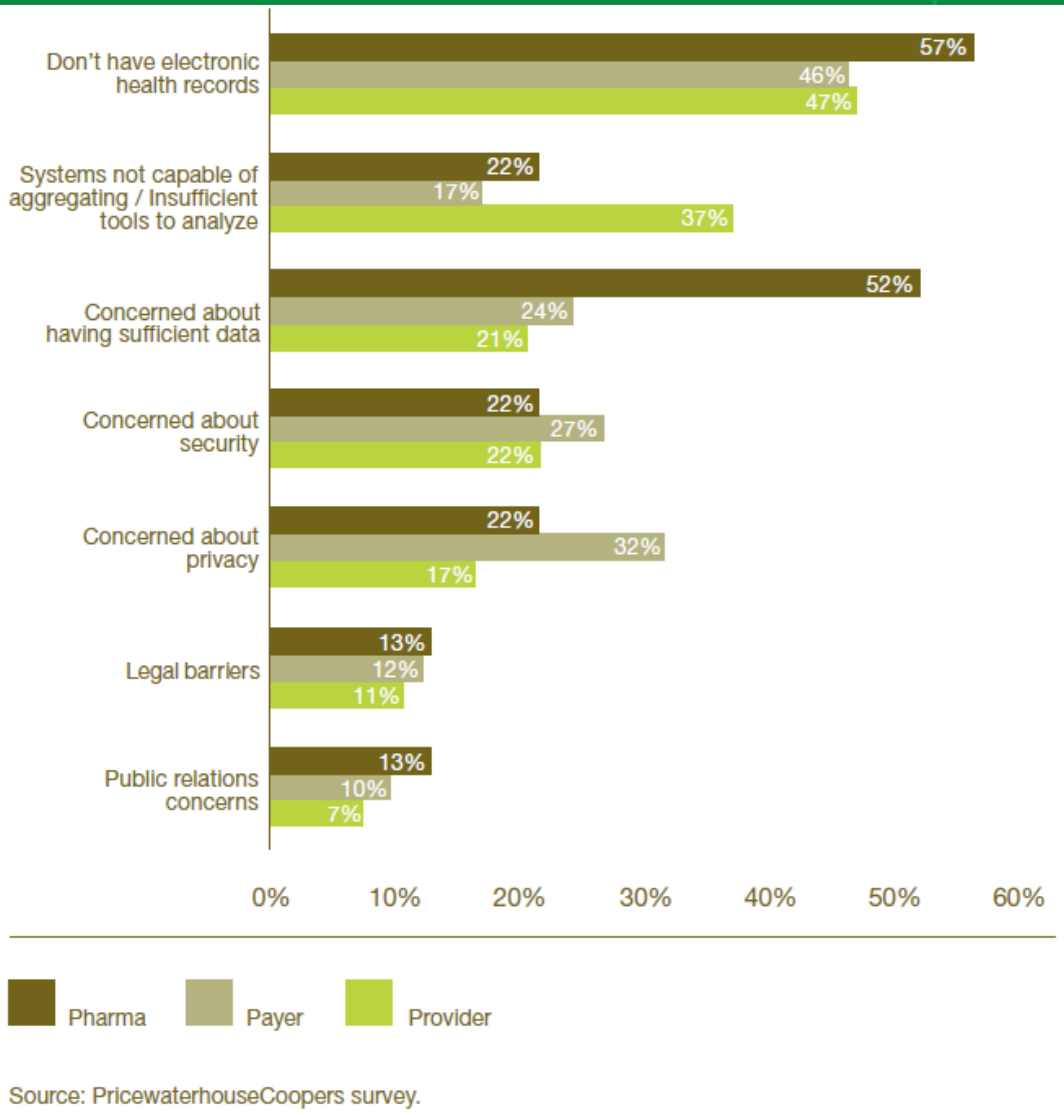
Inpatient



Patient History

- Demographics
- Co-morbidities
- Family History
- Medication History
- Payer/ Formulary Information

Why Isn't Secondary Data Being Used?



Source: PricewaterhouseCoopers survey.

Functions of EHR Systems

Table 3. Electronic Requirements for Classification of Hospitals as Having a Comprehensive or Basic Electronic-Records System.*

Requirement	Comprehensive EHR System	Basic EHR System with Clinician Notes	Basic EHR System without Clinician Notes
Clinical documentation			
Demographic characteristics of patients	√	√	√
Physicians' notes	√	√	
Nursing assessments	√	√	
Problem lists	√	√	√
Medication lists	√	√	√
Discharge summaries	√	√	√
Advanced directives	√		
Test and imaging results			
Laboratory reports	√	√	√
Radiologic reports	√	√	√
Radiologic images	√		
Diagnostic-test results	√	√	√
Diagnostic-test images	√		
Consultant reports	√		
Computerized provider-order entry			
Laboratory tests	√		
Radiologic tests	√		
Medications	√	√	√
Consultation requests	√		
Nursing orders	√		
Decision support			
Clinical guidelines	√		
Clinical reminders	√		
Drug-allergy alerts	√		
Drug–drug interaction alerts	√		
Drug–laboratory interaction alerts (e.g., digoxin and low level of serum potassium)	√		

Jha, A. **Use of Electronic Health Records in U.S. Hospitals** N Engl J Med 2009 360: 1628-1638

Table 1. Survey Items Defining the Use of Electronic Health Records.

Survey Response	Basic System	Fully Functional System
Does your main practice site have a computerized system for any of the following?		
Health information and data		
Patient demographics	X	X
Patient problem lists	X	X
Electronic lists of medications taken by patients	X	X
Clinical notes	X	X
Notes including medical history and follow-up		X
Order-entry management		
Orders for prescriptions	X	X
Orders for laboratory tests		X
Orders for radiology tests		X
Prescriptions sent electronically		X
Orders sent electronically		X
Results management		
Viewing laboratory results	X	X
Viewing imaging results	X	X
Electronic images returned		X
Clinical-decision support		
Warnings of drug interactions or contraindications provided		X
Out-of-range test levels highlighted		X
Reminders regarding guideline-based interventions or screening		X

DesRoches, C. et al. **Electronic Health Records in Ambulatory Care -- A National Survey of Physicians** N Engl J Med 2008 359: 50-60

EHRs in US Ambulatory Care

Electronic Health Records in Ambulatory Care — A National Survey of Physicians

Catherine M. DesRoches, Dr.P.H., Eric G. Campbell, Ph.D., Sowmya R. Rao, Ph.D., Karen Donelan, Sc.D., Timothy G. Ferris, M.D., M.P.H., Ashish Jha, M.D., M.P.H., Rainu Kaushal, M.D., M.P.H., Douglas E. Levy, Ph.D., Sara Rosenbaum, J.D., Alexandra E. Shields, Ph.D., and David Blumenthal, M.D., M.P.P.

ABSTRACT

BACKGROUND

Electronic health records have the potential to improve the delivery of health care services. However, in the United States, physicians have been slow to adopt such systems. This study assessed physicians' adoption of outpatient electronic health records, their satisfaction with such systems, the perceived effect of the systems on the quality of care, and the perceived barriers to adoption.

METHODS

In late 2007 and early 2008, we conducted a national survey of 2758 physicians, which represented a response rate of 62%. Using a definition for electronic health records that was based on expert consensus, we determined the proportion of physicians who were using such records in an office setting and the relationship between adoption and the characteristics of individual physicians and their practices.

RESULTS

Four percent of physicians reported having an extensive, fully functional electronic-records system, and 13% reported having a basic system. In multivariate analyses, primary care physicians and those practicing in large groups, in hospitals or medical centers, and in the western region of the United States were more likely to use electronic health records. Physicians reported positive effects of these systems on several dimensions of quality of care and high levels of satisfaction. Financial barriers were viewed as having the greatest effect on decisions about the adoption of electronic health records.

From the Institute for Health Policy (C.M.D., E.G.C., S.R.R., K.D., D.E.L., A.E.S., D.B.) and the Massachusetts General Physicians Organization (T.G.F.), Massachusetts General Hospital; and Harvard Medical School (A.J.) — both in Boston; Weill Cornell Medical College, New York (R.K.); and the Department of Health Policy, George Washington University, Washington, DC (S.R.). Address reprint requests to Dr. DesRoches at the Institute for Health Policy, Massachusetts General Hospital, Suite 900, 50 Staniford St., Boston, MA 02114, or at cdesroches@partners.org.

This article (10.1056/NEJMsa0802005) was published at www.nejm.org on June 18, 2008.

N Engl J Med 2008;359:50-60.

EHRs in US Hospitals

Use of Electronic Health Records in U.S. Hospitals

Ashish K. Jha, M.D., M.P.H., Catherine M. DesRoches, Dr.Ph., Eric G. Campbell, Ph.D., Karen Donelan, Sc.D., Sowmya R. Rao, Ph.D., Timothy G. Ferris, M.D., M.P.H., Alexandra Shields, Ph.D., Sara Rosenbaum, J.D., and David Blumenthal, M.D., M.P.P.

ABSTRACT

BACKGROUND

Despite a consensus that the use of health information technology should lead to more efficient, safer, and higher-quality care, there are no reliable estimates of the prevalence of adoption of electronic health records in U.S. hospitals.

METHODS

We surveyed all acute care hospitals that are members of the American Hospital Association for the presence of specific electronic-record functionalities. Using a definition of electronic health records based on expert consensus, we determined the proportion of hospitals that had such systems in their clinical areas. We also examined the relationship of adoption of electronic health records to specific hospital characteristics and factors that were reported to be barriers to or facilitators of adoption.

RESULTS

On the basis of responses from 63.1% of hospitals surveyed, only 1.5% of U.S. hospitals have a comprehensive electronic-records system (i.e., present in all clinical units), and an additional 7.6% have a basic system (i.e., present in at least one clinical unit). Computerized provider-order entry for medications has been implemented in only 17% of hospitals. Larger hospitals, those located in urban areas, and teaching hospitals were more likely to have electronic-records systems. Respondents cited capital requirements and high maintenance costs as the primary barriers to implementation, although hospitals with electronic-records systems were less likely to cite these barriers than hospitals without such systems.

From the Department of Health Policy and Management, Harvard School of Public Health (A.K.J.); the Division of General Medicine, Brigham and Women's Hospital (A.K.J.); the Veterans Affairs Boston Healthcare System (A.K.J.); and the Institute for Health Policy (C.M.D., E.G.C., K.D., S.R.R., T.G.F., A.S., D.B.) and the Biostatistics Center (S.R.R.), Massachusetts General Hospital — all in Boston; and the Department of Health Policy, George Washington University, Washington, DC (S.R.). Address reprint requests to Dr. Jha at the Harvard School of Public Health, 677 Huntington Ave., Boston, MA 02115, or at ajha@hsph.harvard.edu.

This article (10.1056/NEJMsa0900592) was published at NEJM.org on March 25, 2009.

N Engl J Med 2009;360:1628-38.

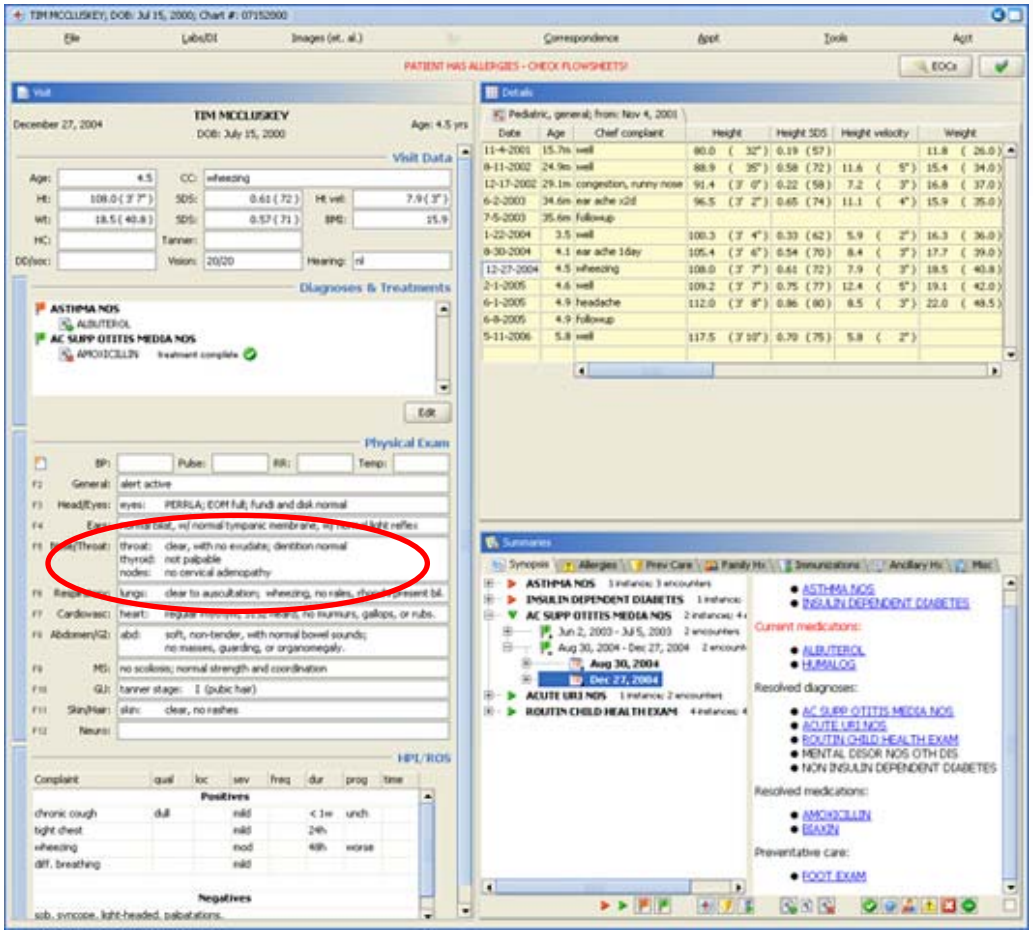
Table 4. Adoption of Comprehensive and Basic Electronic-Records Systems According to

Characteristic	Comprehensive EHR System	Basic EHR System†
		percent of hospitals
Size		
Small (6–99 beds)	1.2±0.3	4.9±0.6
Medium (100–399 beds)	1.7±0.4	8.1±0.8
Large (≥400 beds)	2.6±0.9	15.9±2.2
Region		
Northeast	1.1±0.5	8.9±1.4
Midwest	1.7±0.4	6.6±0.8
South	1.4±0.4	7.3±0.8
West	1.9±0.6	7.0±1.2
Profitability status		
For-profit hospital	1.3±0.5	5.2±1.1
Private nonprofit hospital	1.5±0.3	8.4±0.6
Public hospital	1.7±0.5	5.8±0.9
Teaching status		
Major teaching hospital	2.6±1.1	18.5±2.6
Minor teaching hospital	2.4±0.7	10.6±1.4
Nonteaching hospital	1.3±0.2	5.6±0.5
Member of hospital system		
Yes	2.1±0.4	8.4±0.9
No	1.1±0.2	6.3±0.6
Location		
Urban	1.9±0.3	8.4±0.6
Nonurban	0.6±0.3	4.0±0.7

The Good News about EHRs

- Health Information Technology for Economic and Clinical Health Act or HITECH Act
- This bill accomplishes four major goals that advance the use of HIT:
  - Government to lead in developing standards by 2010 for electronic exchange and to improve quality and coordination of care
  - Invests $20 billion in health information technology infrastructure and incentives to encourage doctors and hospitals to use HIT
  - Saves the government $10 billion through improvements in quality of care and care coordination, and reductions in medical errors and duplicative care.
  - Strengthens Federal privacy and security law to protect identifiable health information from misuse.
- The CBO estimates that 90 percent of doctors and 70 percent of hospitals will be using comprehensive electronic health records within the next decade.

Best for Everyone?



- Not to most physicians
- Still has text-based information

Many Electronic Medical Records Look Like This…

Sample Document - E

Name: Sergio Gratta
#050718
Dr. Anne Jones

HISTORY AND PHYSICAL EXAMINATION

HISTORY

CHIEF COMPLAINT: Respiratory distress.

HISTORY OF PRESENT ILLNESS: The patient has had increasing respiratory distress for the past 12 hours, unrelieved by his usual routine of Capoten. The patient has a long-standing history of severe bronchial asthma, hiatal hernia with reflux and hypertension. No history of nausea, vomiting or other symptoms.

SOCIAL HISTORY: The patient does not smoke or drink or use recreational drugs.

PAST MEDICAL HISTORY: Operations: None. Illnesses: As indicated in the HPI. Allergies: NONE.

REVIEW OF SYSTEMS: Except as mentioned in the HPI, noncontributory.

PHYSICAL EXAMINATION: General: Mr. Gratta is a relatively quiet 56-year-old gentleman who appears in moderate respiratory distress with some intercostal retraction. Vital signs: Blood pressure: 170/100. Respirations: 26. Temperature: 97.2. Heart rate: 135. HEENT: The mucosae re clear. Neck: The neck is supple. No adenopathy is present. Chest: There are diffuse expiratory and inspiratory rhonchi without rales. Cardiovascular: S_1 and S_2 are present in all areas without gallops, rubs or murmurs. Abdomen: The abdomen is soft and nontender without evidence of hepatosplenomegaly. The bowel sounds are hypoactive.
Extremities: No clubbing, cyanosis, edema or calf tenderness.
Neurologic examination: The deep tendon reflexes are normoreflexive and equal bilaterally without evidence of pathologic reflexes.
Rectal exam: Deferred.

IMPRESSION:
Status asthmaticus. Hypertension. History of hiatal hernia. Supraventricular tachycardia.

PLAN: Admit to Weston Medical Center and begin treatment with intravenous steroids, verapamil 80 mg 1.12h., bronchodilators, Tagamet 300 mg q.h.s., Mylanta. PA and lateral chest, EKG, arterial blood gases, electrolytes, SMAC-20. Oxygen per nasal cannula.

Anne Jones, M.D.

D: 3-29-2004
T: 3-29-2004
AJ:jmc

Report Summary: Characters: 2409
65-Character Lines: 37
Gross Lines: 39
Actual Lines: 47

Why?

- Comfortable technology
- Fits with workflow
- Conveys information from physician to physician very effectively

What about Natural Language Processing?

- Extract structured data from text
  - Problems, physical findings, labs
  - Distinguish subtleties of language
    - Negation, distinction of use of topical alcohol from drinking alcohol
    - Complex reasoning:
      - "because of headaches, pt. was switched from Lipitor to Crestor"
  - Major issue is de-identifying information

NLP Example

PAST MEDICAL HISTORY:
The patient's past medical history is significant for multiple vaso occlusive crisis requiring multiple admissions to the hospital, aplastic crisis, urinary tract infection, many transfusions. The patient had a history of right knee infarct.
HISTORY OF PRESENT ILLNESS:
The patient is a 21 year old black female with hemoglobin SS disease who
was admitted with complaints of vaso occlusive crisis of her back, both knees and her left arm. In Area A the patient had four intramuscular injections of Dilaudid without relief so she is admitted for further treatment.
HOSPITAL COURSE:
The patient was given vigorous p.o. hydration and started on Dilaudid 3 mg intramuscular or subcutaneously q.
2 hours with Benadryl 50 mg intramuscularly q.
4 hours with alternating Dilaudid doses.
The patient was given Motrin p.r.n. as well.
The medications also included Folate 1 mg q.d. and Colace 100 mg p.o. t.i.d.
The patient reported her pain to be without change for the first few days of admission. On the fourth day of admission the patient noted pain to be decreased and the Dilaudid was decreased to 2 mg alternating with 3 mg intramuscularly every two hours.
On the tenth day of admission the patient was switched to Percocet tablets two p.o. q.
4 hours p.r.n. for pain.
The patient chose to go home on p.o.
Percocet. The patient was discharged home on 4/28/95 with the following prescriptions:
Percocet # 50 to follow up in the Hematology Clinic with Dr. Dugood in two weeks.

Source: NLP International

NLP Example, highlights

PAST MEDICAL HISTORY:

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Source: NLP International

NLP Example: Coded

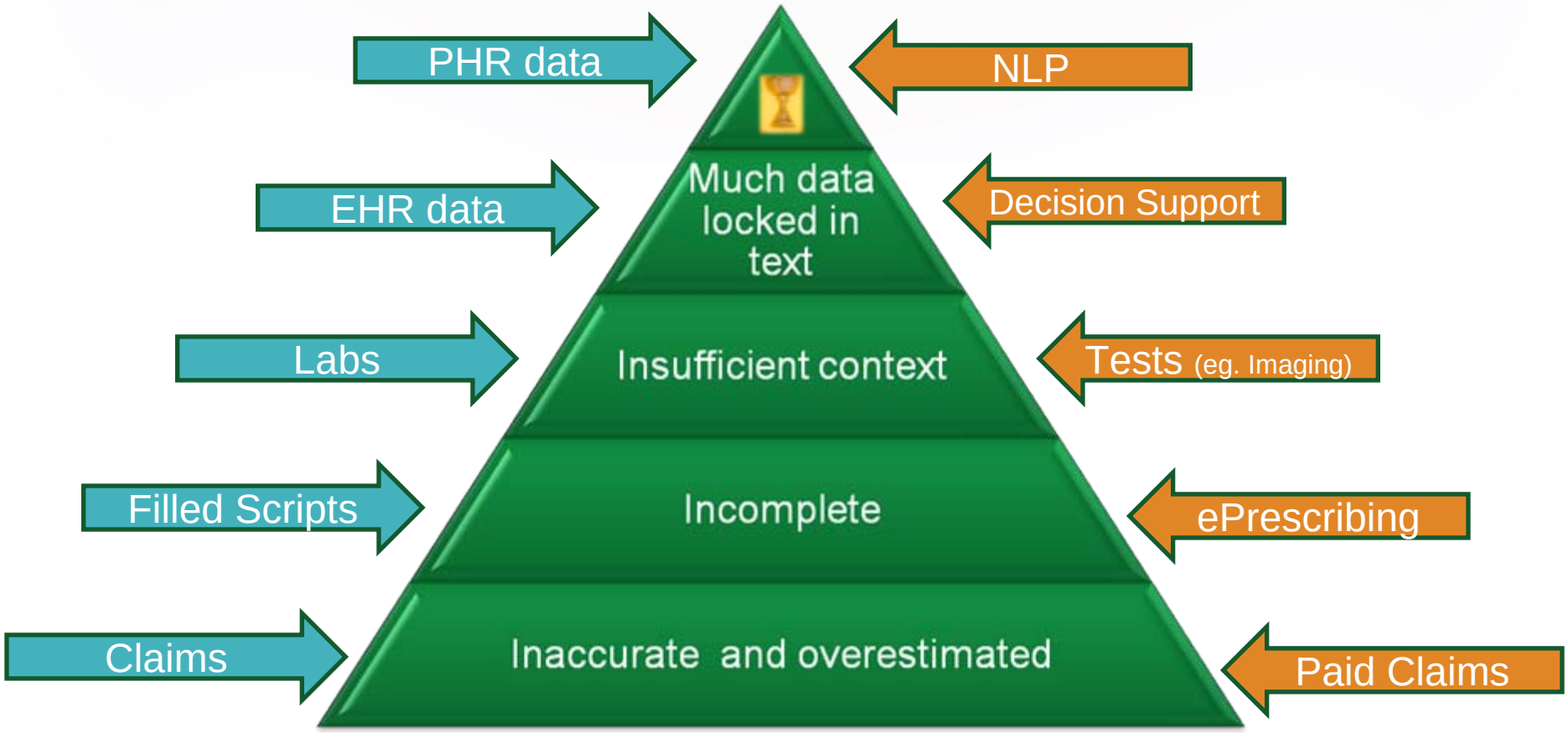
```
                    idref>> [27]
problem:aplastic crisis
            idref>> 46
            parsemode>> mode1
            sectname>> report past history item
            sid>> 1
            timeper>> admission
                    idref>> 37
                    service>> hospital
                            idref>> 43
                            location>> to
                                    idref>> 39
            code>> UMLS:C0302111_Aplastic crisis
                    idref>> [46]
problem:urinary tract infection
            certainty>> high certainty
                    idref>> 49
            idref>> 51
            parsemode>> mode1
            sectname>> report past history item
            sid>> 1
            timeper>> admission
                    idref>> 37
                    service>> hospital
                            idref>> 43
                            location>> to
                                    idref>> 39
            code>> UMLS:C0042029_Urinary tract infection
                    idref>> [51]
procedure:transfusion
            certainty>> high certainty
                    idref>> 56
            idref>> 60
            parsemode>> mode1
            quantity>> [many,[idref,58]]
            sectname>> report past history item
```


Source: NLP International

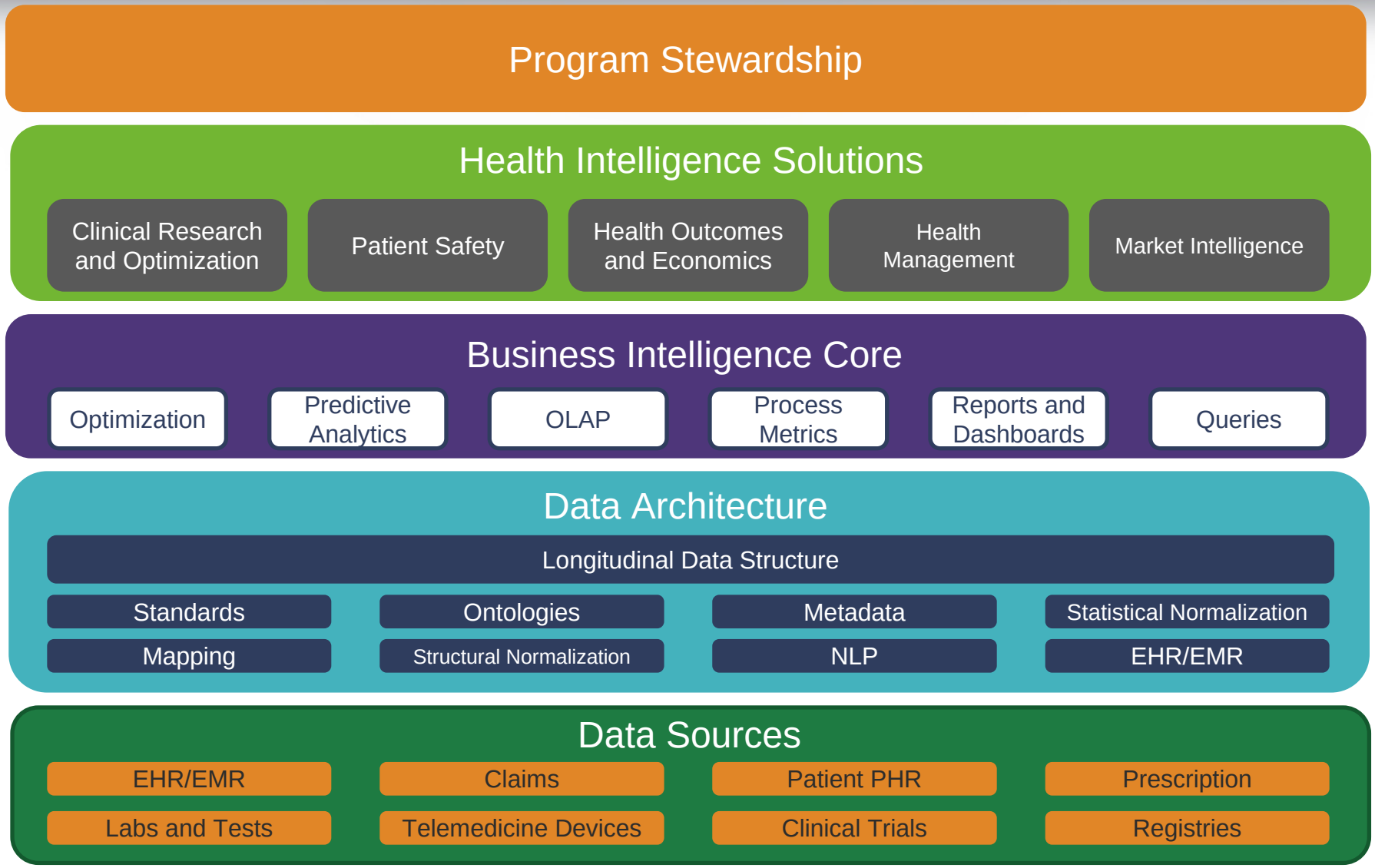
Principles of Secondary Health Data Analytics

- Patient focus for all data activities
  - All uses should benefit patients
  - Minimal disclosure of data to meet need
  - Never allow re-identification of patients
- Data uses must be transparent
  - Overseen by honest brokers or stewards
  - Everyone in the process is a data steward
- Data must be collected THROUGH the process of care, not in addition to it
- Data analytics for analysis of outcomes, value and comparative effectiveness must be the goal. This will require:
  - New data architectures
  - New expertise for experts in data visualization and predictive analytics
  - New training for others in understanding the output of these efforts

The Pyramid of Value



Health Data Integration Framework



Adapted from: CSC

Creating a Quality Cycle in Healthcare

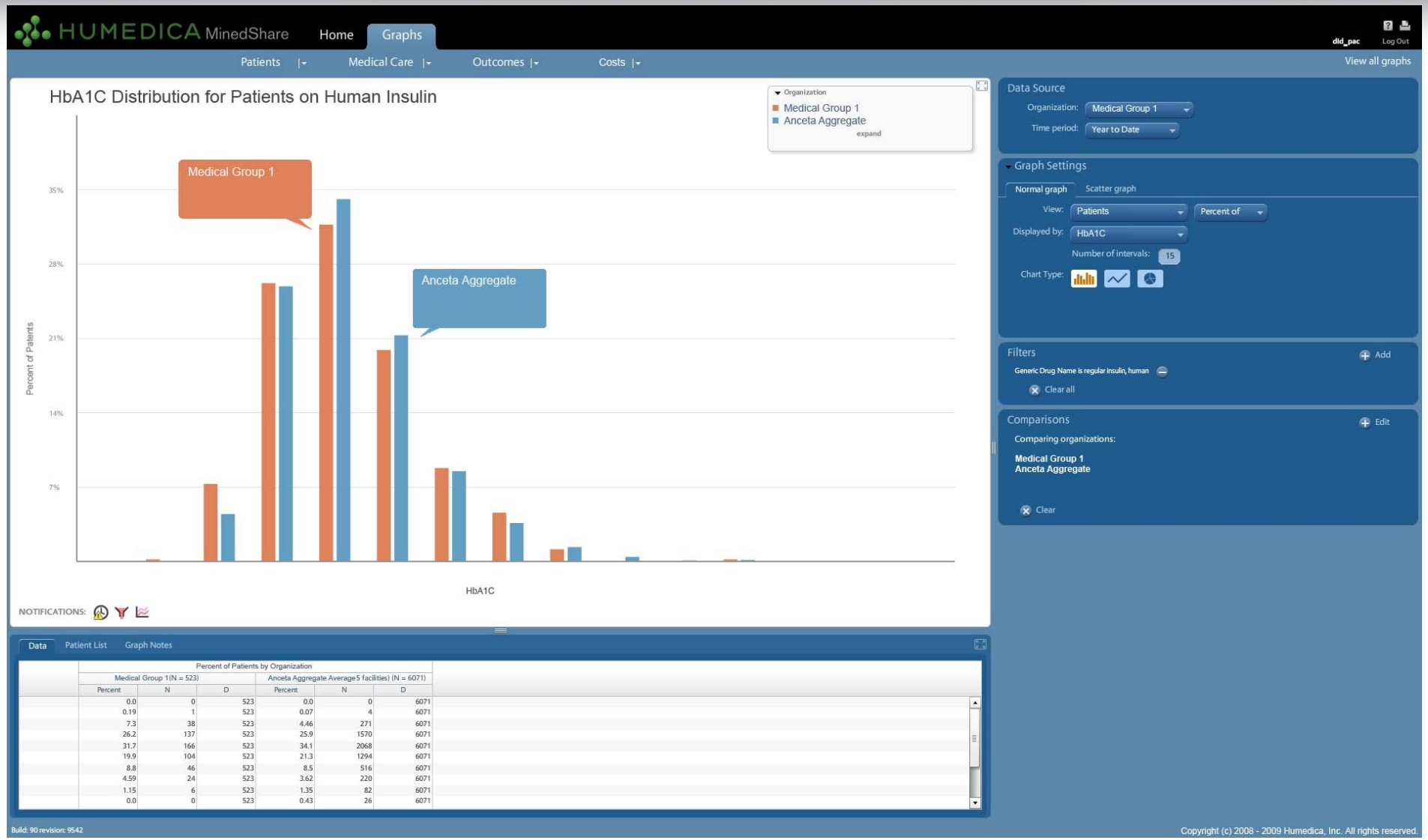
- ***Identify*** **new issues and opportunities**
- ***Improve*** **operational performance and patient outcomes**
- ***Track*** **clinical performance and compare results**
- ***Optimize*** **data to improve payer reimbursement**

Key Performance Indicators for Clinical Measures

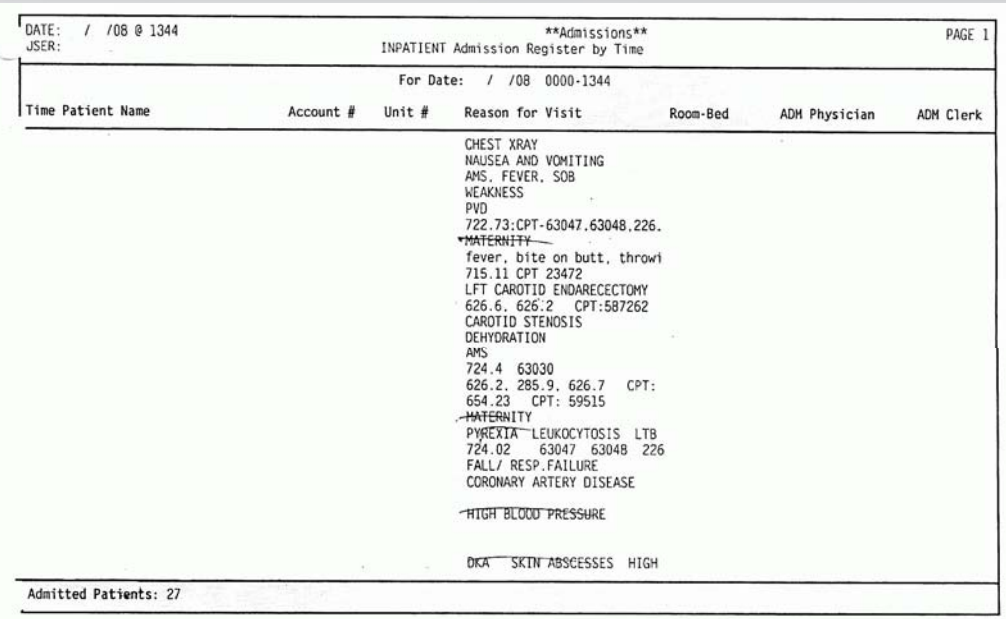
Measure	Daily	Daily Budget	Month To Date Nov 2009	MTD Budget Nov 2009	Achievement		Period -1 Oct 2009	Period -2 Sep 2009	Period -3 Aug 2009
Activity Indicators									
ADC	34	41	36	41	87.53%	✓	37	35	44
Discharges	‡	4	27	29	93.75%	✓	95	97	108
Patient Days	34	41	285	326	87.53%	✓	1,137	1,050	1,371
ALOS Total	‡	11.30	12.26	11.30	108.49%	✓	11.57	11.14	13.09
ALOS Medicare	‡	11.56	11.10	11.56	95.98%	✓	11.88	11.43	12.64
CMI Total	‡	1.23	1.18	1.23	96.32%	✓	1.20	1.25	1.24
CMI Medicare	‡	1.24	1.19	1.24	95.66%	✓	1.20	1.25	1.23
Observations	‡	0	‡	0	‡		‡	‡	‡
ER Visits	‡	0	‡	0	‡		1	5	‡
Surgery IP	‡	0	0	0	100.00%	✓	0	0	0
Surgery OP						✓			

- Static, and difficult to explore new relationships and make new observations

Business Intelligence Tools for Clinical Performance and Benchmarking



Identifying Patients for Acute Myocardial Infarction Core Measure Monitoring



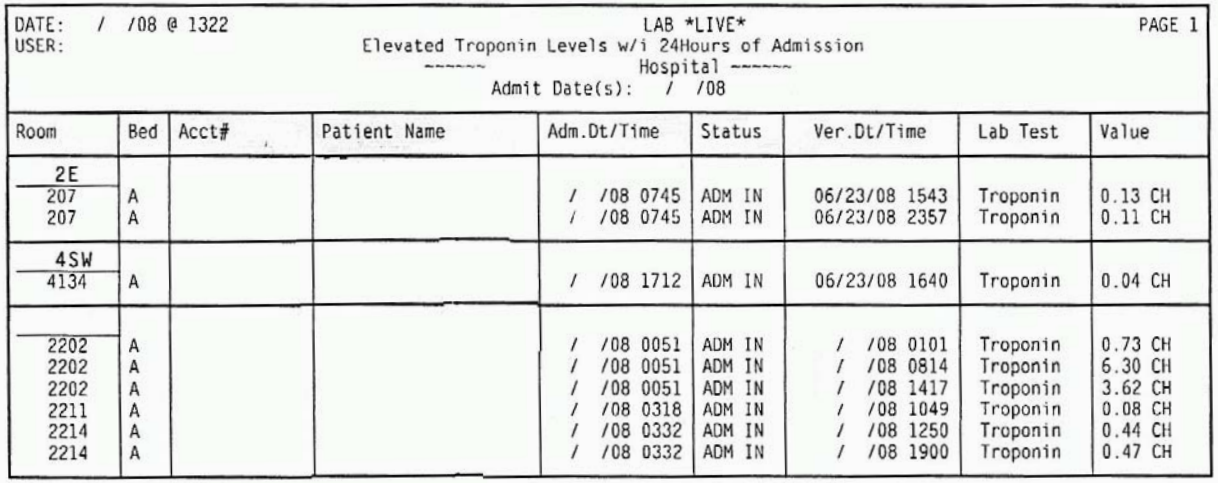
DATE: / /08 @ 1344 **Admissions** PAGE 1
USER: INPATIENT Admission Register by Time

For Date: / /08 0000-1344

Time	Patient Name	Account #	Unit #	Reason for Visit	Room-Bed	ADM Physician	ADM Clerk
				CHEST XRAY			
				NAUSEA AND VOMITING			
				AMS, FEVER, SOB			
				WEAKNESS			
				PVD			
				722.73:CPT-63047.63048.226.			
				~~MATERNITY~~			
				fever, bite on butt, throwi			
				715.11 CPT 23472			
				LFT CAROTID ENDARECECTOMY			
				626.6, 626.2 CPT:587262			
				CAROTID STENOSIS			
				DEHYDRATION			
				AMS			
				724.4 63030			
				626.2, 285.9, 626.7 CPT:			
				654.23 CPT: 59515			
				~~MATERNITY~~			
				PYREXIA LEUKOCYTOSIS LTB			
				724.02 63047 63048 226			
				FALL/ RESP.FAILURE			
				CORONARY ARTERY DISEASE			
				~~HIGH BLOOD PRESSURE~~			
				DKA SKIN ABSCESSES HIGH			

Admitted Patients: 27

- Manual matching of admissions markers of AMI (labs)
- Physician/nursing notification
- Inefficient, time consuming, costly, and error prone



DATE: / /08 @ 1322 LAB *LIVE* PAGE 1
USER: Elevated Troponin Levels w/i 24Hours of Admission
~~~~~~ Hospital ~~~~~~
Admit Date(s): / /08

Room	Bed	Acct#	Patient Name	Adm.Dt/Time	Status	Ver.Dt/Time	Lab Test	Value
2E								
207	A			/ /08 0745	ADM IN	06/23/08 1543	Troponin	0.13 CH
207	A			/ /08 0745	ADM IN	06/23/08 2357	Troponin	0.11 CH
4SW								
4134	A			/ /08 1712	ADM IN	06/23/08 1640	Troponin	0.04 CH
2202	A			/ /08 0051	ADM IN	/ /08 0101	Troponin	0.73 CH
2202	A			/ /08 0051	ADM IN	/ /08 0814	Troponin	6.30 CH
2202	A			/ /08 0051	ADM IN	/ /08 1417	Troponin	3.62 CH
2211	A			/ /08 0318	ADM IN	/ /08 1049	Troponin	0.08 CH
2214	A			/ /08 0332	ADM IN	/ /08 1250	Troponin	0.44 CH
2214	A			/ /08 0332	ADM IN	/ /08 1900	Troponin	0.47 CH

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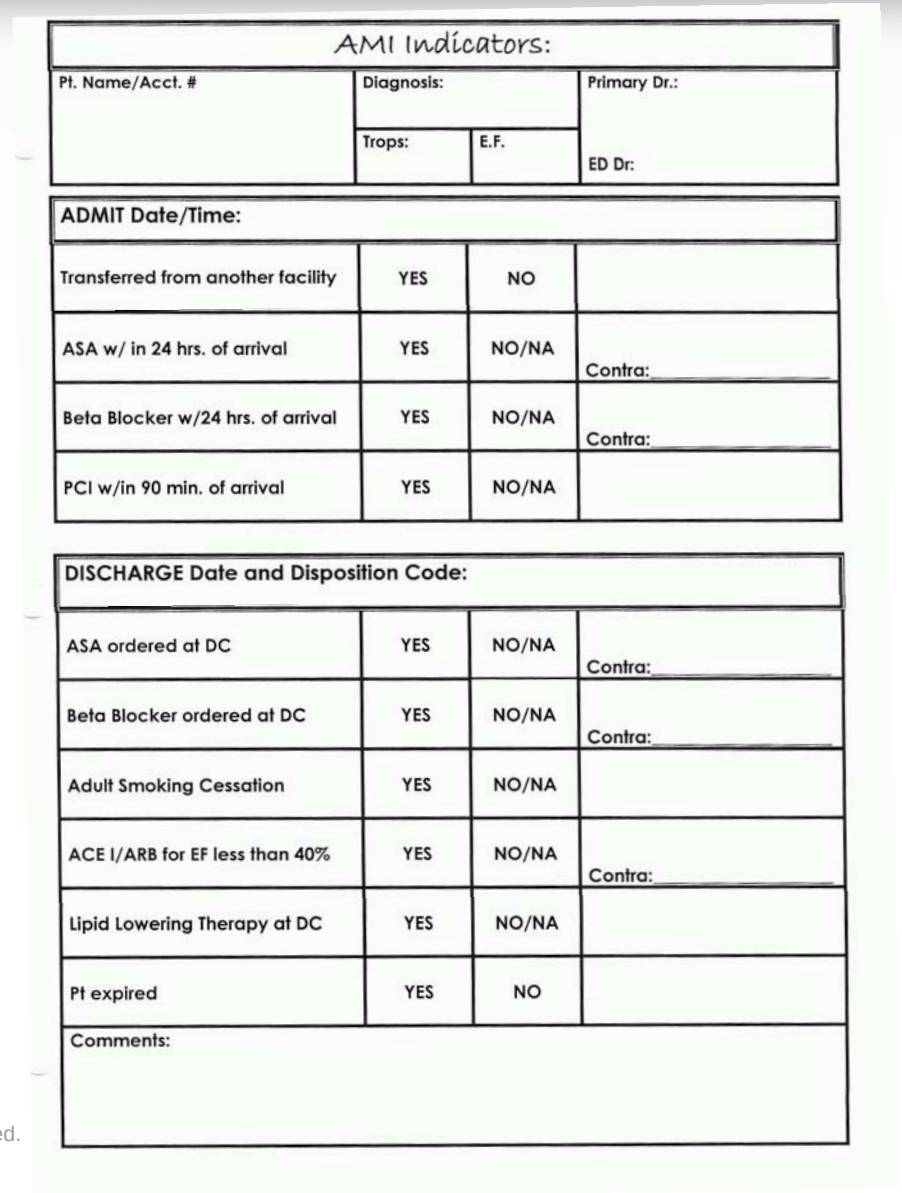
Recording of AMI Core Measure Data



AMI Indicators:

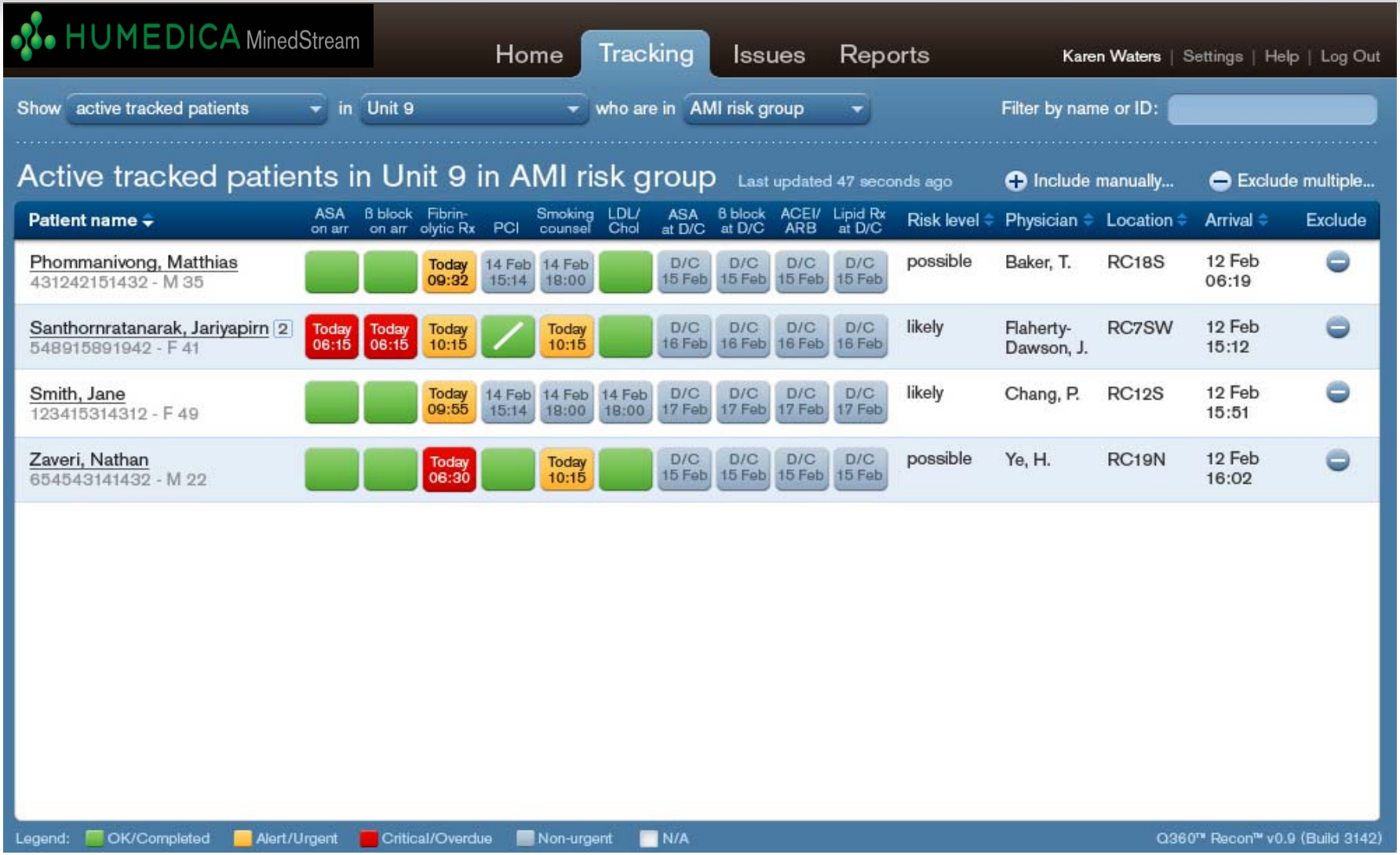
Pt. Name/Acct. #	Diagnosis:		Primary Dr.:
	Trops:	E.F.	ED Dr:

ADMIT Date/Time:			
Transferred from another facility	YES	NO	
ASA w/ in 24 hrs. of arrival	YES	NO/NA	Contra:
Beta Blocker w/24 hrs. of arrival	YES	NO/NA	Contra:
PCI w/in 90 min. of arrival	YES	NO/NA	

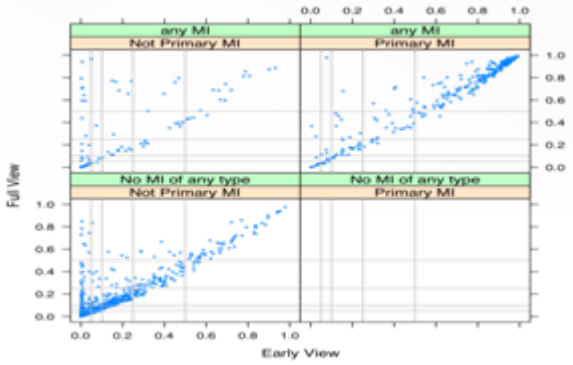
DISCHARGE Date and Disposition Code:			
ASA ordered at DC	YES	NO/NA	Contra:
Beta Blocker ordered at DC	YES	NO/NA	Contra:
Adult Smoking Cessation	YES	NO/NA	
ACE I/ARB for EF less than 40%	YES	NO/NA	Contra:
Lipid Lowering Therapy at DC	YES	NO/NA	
Pt expired	YES	NO	
Comments:			

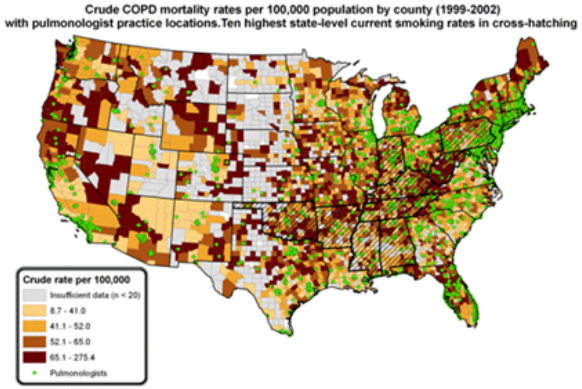
 |

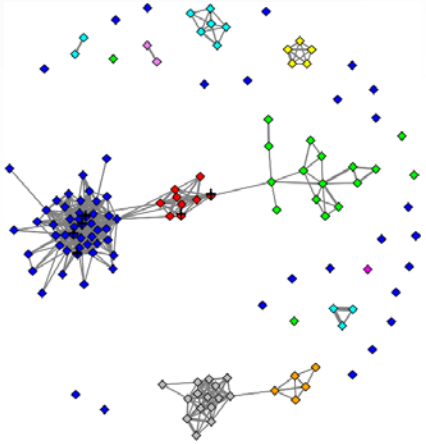
Real Time Operational Performance Improvement in Healthcare

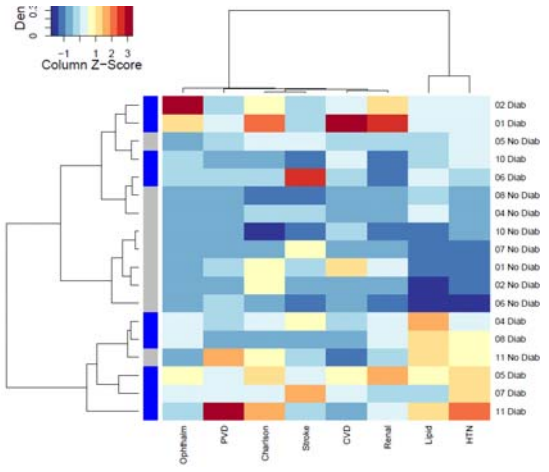


Data Mining: Insight and Value from Healthcare Data









- **Data Visualization**
- **Predictive Analytics**
- **Network and Clustering Analysis**
- **Geographical Analysis (GIS)**

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