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

True Longitudinal Patient Records

Patient Encounter

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

Outpatient

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

Inpatient

Treatment triggers, therapeutic choices and associated outcomes

Pharmacy

Radiology

Lab

ED
Why Isn’t Secondary Data Being Used?

- Don’t have electronic health records: 57%
- Systems not capable of aggregating/insufficient tools to analyze: 22%
- Concerned about having sufficient data: 24%
- Concerned about security: 22%
- Concerned about privacy: 22%
- Legal barriers: 13%
- Public relations concerns: 13%

Source: PricewaterhouseCoopers survey.
# Functions of EHR Systems

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

<table>
<thead>
<tr>
<th>Requirement</th>
<th>Basic System</th>
<th>Fully Functional System</th>
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<tbody>
<tr>
<td><strong>Clinical documentation</strong></td>
<td></td>
<td></td>
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<tr>
<td>Demographic characteristics of patients</td>
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<tr>
<td>Physician notes</td>
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<tr>
<td>Nursing assessments</td>
<td>X</td>
<td>X</td>
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<tr>
<td>Problem lists</td>
<td>X</td>
<td>X</td>
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<tr>
<td>Medication lists</td>
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<tr>
<td>Discharge summaries</td>
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<tr>
<td>Advanced directives</td>
<td>X</td>
<td>X</td>
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<tr>
<td><strong>Test and imaging results</strong></td>
<td></td>
<td></td>
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<tr>
<td>Laboratory reports</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>Radiologic reports</td>
<td>X</td>
<td>X</td>
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<tr>
<td>Radiologic images</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>Diagnostic-test results</td>
<td>X</td>
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</tr>
<tr>
<td>Diagnostic-test images</td>
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<td>X</td>
</tr>
<tr>
<td>Consultant reports</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td><strong>Computerized provider-order entry</strong></td>
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<tr>
<td>Laboratory tests</td>
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<td>X</td>
</tr>
<tr>
<td>Radiologic tests</td>
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<td>Medications</td>
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<td>Nursing orders</td>
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<td><strong>Decision support</strong></td>
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<td>Clinical guidelines</td>
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<tr>
<td>Clinical reminders</td>
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<tr>
<td>Drug-allergy alerts</td>
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<tr>
<td>Drug–drug interaction alerts</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>Drug–laboratory interaction alerts (e.g., digoxin and low level of serum potassium)</td>
<td>X</td>
<td>X</td>
</tr>
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</table>

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

<table>
<thead>
<tr>
<th>Requirement</th>
<th>Comprehensive EHR System</th>
<th>Basic EHR System with Clinician Notes</th>
<th>Basic EHR System without Clinician Notes</th>
</tr>
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<tbody>
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<td>Clinical documentation</td>
<td>✓</td>
<td>✓</td>
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<tr>
<td>Demographic characteristics of patients</td>
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<tr>
<td>Physicians’ notes</td>
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<tr>
<td>Nursing assessments</td>
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</tr>
<tr>
<td>Problem lists</td>
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<td>✓</td>
</tr>
<tr>
<td>Medication lists</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>Discharge summaries</td>
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<td>✓</td>
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<tr>
<td>Advanced directives</td>
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<tr>
<td>Test and imaging results</td>
<td>✓</td>
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<tr>
<td>Laboratory reports</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>Radiologic reports</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
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<tr>
<td>Radiologic images</td>
<td>✓</td>
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<tr>
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<tr>
<td>Radiologic tests</td>
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</tr>
<tr>
<td>Medications</td>
<td>✓</td>
<td>✓</td>
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<tr>
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<td>✓</td>
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<td>✓</td>
</tr>
<tr>
<td>Nursing orders</td>
<td>✓</td>
<td>✓</td>
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</tbody>
</table>


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


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.
**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**

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.
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…

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
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.
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4 hours with alternating Dilaudid doses.

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The medications also included Folate 1 mg q.d. and Colace 100 mg p.o. t.i.d.
NLP Example: Coded

```xml
<problem:aplastic_crisis>
  <idref>[27]</idref>
</problem:aplastic_crisis>

<problem:urinary_tract_infection>
  <certainty>high</certainty>
  <idref>[49]</idref>
  <idref>[51]</idref>
</problem:urinary_tract_infection>

<procedure:transfusion>
  <certainty>high</certainty>
  <idref>[56]</idref>
  <idref>[60]</idref>
  <quantity>[many, [idref, [58]]]</quantity>
</procedure:transfusion>
```
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

- PHR data
- EHR data
- Labs
- Filled Scripts
- Claims
- NLP
- Decision Support
- Tests (eg. Imaging)
- ePrescribing
- Paid Claims

- Many data locked in text
- Insufficient context
- Incomplete
- Inaccurate and overestimated
## Health Data Integration Framework

### Program Stewardship

### Health Intelligence Solutions
- Clinical Research and Optimization
- Patient Safety
- Health Outcomes and Economics
- Health Management
- Market Intelligence

### Business Intelligence Core
- Optimization
- Predictive Analytics
- OLAP
- Process Metrics
- Reports and Dashboards
- Queries

### Data Architecture

#### Longitudinal Data Structure
- Standards
- Ontologies
- Metadata
- Statistical Normalization
- Mapping
- Structural Normalization
- NLP
- EHR/EMR

### Data Sources
- EHR/EMR
- Claims
- Patient PHR
- Prescription
- Labs and Tests
- Telemedicine Devices
- Clinical Trials
- Registries

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

<table>
<thead>
<tr>
<th></th>
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<th></th>
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<tbody>
<tr>
<td>ADC</td>
<td>34*</td>
<td>41*</td>
<td>36*</td>
<td>41*</td>
<td>87.53%* ✓</td>
<td>37*</td>
<td>35*</td>
<td>44*</td>
</tr>
<tr>
<td>Discharges</td>
<td>†</td>
<td>4*</td>
<td>27*</td>
<td>29*</td>
<td>93.75%* ✓</td>
<td>95*</td>
<td>97*</td>
<td>108*</td>
</tr>
<tr>
<td>Patient Days</td>
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<td>41*</td>
<td>286*</td>
<td>326*</td>
<td>87.53%* ✓</td>
<td>1,137*</td>
<td>1,050*</td>
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<td>ALOS Total</td>
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<td>11.30*</td>
<td>12.26*</td>
<td>11.30*</td>
<td>108.49%* ✓</td>
<td>11.57*</td>
<td>11.14*</td>
<td>13.09*</td>
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<td>ALOS Medicare</td>
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<td>95.98%* ✓</td>
<td>11.88*</td>
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<td>12.64*</td>
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<td>CMI Total</td>
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<td>CMI Medicare</td>
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<td>1.19*</td>
<td>1.24*</td>
<td>95.66%* ✓</td>
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<td>1*</td>
<td>5*</td>
<td>†*</td>
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<td>100.00%* ✓</td>
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<td>0*</td>
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</table>

• 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

• Manual matching of admissions markers of AMI (labs)
• Physician/nursing notification
• Inefficient, time consuming, costly, and error prone
### Recording of AMI Core Measure Data

#### AMI Indicators:

<table>
<thead>
<tr>
<th>Indicators</th>
<th>YES</th>
<th>NO</th>
</tr>
</thead>
<tbody>
<tr>
<td>Diagnosis</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Primary Dr.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Transferred from another facility</td>
<td></td>
<td></td>
</tr>
<tr>
<td>ASA w/in 24 hrs. of arrival</td>
<td>YES</td>
<td>NO/NA</td>
</tr>
<tr>
<td>Beta Blocker w/24 hrs. of arrival</td>
<td>YES</td>
<td>NO/NA</td>
</tr>
<tr>
<td>PCI w/in 90 min. of arrival</td>
<td>YES</td>
<td>NO/NA</td>
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</tbody>
</table>

#### DISCHARGE Date and Disposition Code:

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<tr>
<th>Indicators</th>
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<th>NO/NA</th>
</tr>
</thead>
<tbody>
<tr>
<td>ASA ordered at DC</td>
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<td></td>
</tr>
<tr>
<td>Beta Blocker ordered at DC</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Adult Smoking Cessation</td>
<td></td>
<td></td>
</tr>
<tr>
<td>ACE I/ARB for EF less than 40%</td>
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<td></td>
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<tr>
<td>Lipid Lowering Therapy at DC</td>
<td></td>
<td></td>
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<tr>
<td>Pt expired</td>
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<td>NO</td>
</tr>
</tbody>
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#### Comments:

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<table>
<thead>
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</thead>
</table>

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Data Mining: Insight and Value from Healthcare Data

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