The (Big) Data Dividend of Electronic Health Records in the United States: A Learning Health System

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Thank You

U.S. News in One Slide

Election Day: Nov 8

- Never have there been two candidates with lower disapproval ratings . . .

The "World Series"
Cleveland Indians vs. Chicago Cubs

U.S. Healthcare in One Slide

- Predominantly Fee-for-Service, but moving to Value
- Service delivery highly fragmented; limited focus on health
- Can get exceptional care; not everyone does
- Cost outpacing economic growth

American Hospital Association

- National organization of > 5,000 hospitals, health care systems, networks, other providers of care and 43,000 individual members
- Founded in 1898, AHA provides education for health care leaders and is a source of information and support for health care policy, operations and improvement
- Vision:
  — The AHA vision is of a society of healthy communities, where all individuals reach their highest potential for health

American College of Healthcare Executives

- Professional leadership society of more than 40,000 healthcare executives
- Individual membership association, founded in 1933
- Foremost provider of continuing education and publications for healthcare management and leadership
- Mission:
  — To advance our members and healthcare management excellence
In the year 2009, the U.S. was in the "great recession." Despite the precarious economy, the cost of healthcare continued to rise, and most healthcare encounters were recorded on . . .

Comparing Performance in U.S. Healthcare & Aviation

- Airline Safety: > 99.999999
- Airline Baggage Handling: > 99.999
- B-Blocker p MI: ~99.5%
- Patient Immunization: 55 – 94%
- Hand Hygiene: 3 – 40% (37% overall)

Leading Causes of Mortality in the United States

<table>
<thead>
<tr>
<th>Rank</th>
<th>Issue</th>
<th>Number</th>
<th>20 Year Trend</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Diseases of heart</td>
<td>652,486</td>
<td>ë</td>
</tr>
<tr>
<td>2</td>
<td>Malignant neoplasms (cancer)</td>
<td>553,888</td>
<td>ë</td>
</tr>
<tr>
<td>3</td>
<td>Cerebrovascular diseases</td>
<td>150,074</td>
<td>ê</td>
</tr>
<tr>
<td>4</td>
<td>Chronic lower respiratory diseases</td>
<td>121,987</td>
<td>ê</td>
</tr>
<tr>
<td>5</td>
<td>Unintentional injuries</td>
<td>112,012</td>
<td>ê</td>
</tr>
<tr>
<td>6</td>
<td>Diabetes mellitus</td>
<td>73,136</td>
<td>ë</td>
</tr>
<tr>
<td>7</td>
<td>Alzheimer’s diseases</td>
<td>63,965</td>
<td>ë</td>
</tr>
<tr>
<td>8</td>
<td>Influenza and pneumonia</td>
<td>58,094</td>
<td>ë</td>
</tr>
<tr>
<td>9</td>
<td>Nephritis, nephrotic syndrome, and nephrosis</td>
<td>42,490</td>
<td>ë</td>
</tr>
</tbody>
</table>

1-in-5 Medicare (>65) Patients Rehospitalized in 30 Days

- 50.2% of patients had NO outpatient follow-up within 30 days of hospital discharge

Overview

1. Background: HITECH & Meaningful Use
2. Transforming Care by Learning at-Scale
   - The REDUCE MRSA Trial
   - The Case of the Billion-Dollar Babies
3. Harvesting the (Big) "Data-Dividend"
   - Health (Payment) Reform
   - Improving Care
Health IT: The “Meaningful Use” (MU) Program

MU is a Program in the “HITECH” (Health Information Technology for Economic & Clinical Health) of ARRA:

• An “Interstate Highway Program” for Health Information
  – Envisioned Interoperable Electronic Health Records
• Offered Financial Incentives to Hospitals & Physicians to adopt Electronic Health Records over a rolling four-year period, ending NLT 2017
  – Healthcare in U.S. is ~ 18% U.S. economy (~$3T)
  – > $9,500 per capita
• Over $32 BILLION in incentives have been distributed
  • Hospitals not achieving MU would ultimately experience (incapacitating) payment penalties

“Meaningful Use” (MU)

Earning Incentives / Avoiding Penalties Requires Hospitals & Providers to:

• Use “Certified” Electronic Health Records (EHR) incorporating Specified Data Standards
• Progressively Increase Use of EHR for
  – Physician Order Entry (e.g., labs, medications, imaging)
  – Demonstrate interoperability and information exchange by sharing patient records with other providers and with patients
  – Providing certain public health data to authorities
  – Demonstrating use of clinical decision support
  – Submitting specified electronic measures of care quality

A Little Quick Math . . .

323,000,000 – U.S. Pop 2015

~ $100 per person … for “Meaningful Use” of Health Information Technology (HIT)
So, how’s our investment doing?

Crossing the Digital Divide . . . Hospital Adoption

Hospitals Receiving Incentive Payments for Electronic Health Record Adoption or Meaningful Use (Quick-Stat 10)

May 2011

December 2013

Hospitals have adopted and used Electronic Health Records (EHR) at rapid rate across the country since the inception of the CMS/EHR incentive Program. As of December 2013, ~10% of all U.S. hospitals had adopted and used Electronic Health Records (EHR). The incentive Program is designed to encourage widespread adoption of EHRs. In December 2013, ~28% of hospitals had adopted and used EHRs.

2016: Approximately 98% hospitals computerized
Limited point-to-point interoperability

Crossing the Digital Divide . . . Physician Adoption

Percent of Physicians e-Prescribing through an Electronic Health Record (Quick-Stat 11)

2008

2013

In the past five years, physician Electronic Health Record (EHR) adoption has soar, reaching all corners of the country. The percentage of physicians using EHRs has increased from 19% in 2008 to 69% in 2013. The percentage of physicians using EHRs is expected to be even higher in 2016.

2016: Approximately 95% physicians computerized
Limited point-to-point interoperability
The Data Dividend: Learning Healthcare

Creating Data

Advanced Analytics

Data Generation

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The REDUCE MRSA Trial – Background

Addressing a Significant Problem:

- In the United States, ~ 1 in 20 U.S. patients will develop a healthcare-associated infection (HAIs) in hospital
- ~ 1.6 million patients infected
- ~ 70,000 die (> MVA + HIV + BCA)
- ~ $20 – 30 billion avoidable healthcare expenditures
- Methicillin-resistant Staphylococcus aureus (MRSA), and other Staphylococcus aureus, account for approximately 25% of all deaths from HAIs

What Might be Learned Across a Large Health System?

- 28 million patient episodes annually
- Approximately 5% of major hospital services in U.S.

<table>
<thead>
<tr>
<th>MRSA ABC’s:</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Active Surveillance</td>
</tr>
<tr>
<td>• Barrier Precautions</td>
</tr>
<tr>
<td>• Compulsive Hand Hygiene</td>
</tr>
<tr>
<td>• Disinfection</td>
</tr>
<tr>
<td>• Executive Ownership</td>
</tr>
</tbody>
</table>

Table 2. Rate of Clifford and VAP due to MRSA in Adult ICU

<table>
<thead>
<tr>
<th>Outcome</th>
<th>Infection</th>
<th>Pseudonecrosis</th>
</tr>
</thead>
<tbody>
<tr>
<td>Deaths</td>
<td>3</td>
<td>2</td>
</tr>
<tr>
<td>Length of Stay</td>
<td>28</td>
<td>24</td>
</tr>
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The REDUCE MRSA Trial – What Begged the Question?

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What Might be Learned Across a Large Health System?

- Largest provider of uncompensated care, Medicaid services to a population more diverse than U.S. pop.
Could MU in HCA Provide a Platform for REDUCE MRSA Trial?

Pragmatic Research – Implemented in course of routine care, in routine setting, not dedicated research unit

Comparative Effectiveness study – Comparing (three) competing “best practices” to determine what is truly “best”

Cluster-Randomized (by hospital) trial design

1. Screen & Isolate: Screen every patient and implement barrier isolation, if MRSA positive ( HCA’s “base case” with SIR < 0.7 )

2. Targeted Decolonization: Screen, and if MRSA-positive, isolate and decolonize (using chlorhexidine antimicrobial soap and mupurocin nasal ointment)

3. Universal Decolonization: Decolonize all patients on admission to ICU

REDUCE MRSA: Timeline & Enrollment

Baseline 12 month Phase In Intervention 18 month

HITECH (MU I) Jan 2010 Apr 2010 Sep 2011

As Randomized

<table>
<thead>
<tr>
<th>Arm 1</th>
<th>Arm 2</th>
<th>Arm 3</th>
</tr>
</thead>
<tbody>
<tr>
<td>16 Hospitals (23 ICUs) N = 23,480</td>
<td>14 Hospitals (22 ICUs) N = 24,752</td>
<td>13 Hospitals (29 ICUs) N = 28,924</td>
</tr>
</tbody>
</table>

As Treated

<table>
<thead>
<tr>
<th>Arm 1</th>
<th>Arm 2</th>
<th>Arm 3</th>
</tr>
</thead>
<tbody>
<tr>
<td>16 Hospitals N = 23,480</td>
<td>14 Hospitals N = 22,105</td>
<td>13 Hospitals N = 26,024</td>
</tr>
</tbody>
</table>

Aggregate: 43 Hospitals; 74,356 patients; 282,803 patient-days

REDUCE MRSA: Results (All Pathogen Bloodstream Infection)

![Graph showing results of REDUCE MRSA study](image)

- Overall P<0.0001
- Arm 2 vs 1 P=0.04
- Arm 3 vs 1 P<0.0001
- Arm 3 vs 2 P=0.003

REDUCE MRSA: Study Findings

Decolonization reduces all blood stream infections (BSIs) by 44% and MRSA by 37%

- For every 99 patients decolonized, 1 BSI was avoided
- Set a new standard for reducing BSIs in ICUs
- Policy: Demonstrated that (9) state-mandated screening were expensive and inappropriate

REDUCE MRSA: Discussion

Fostering a Learning Health System

- REDUCE MRSA notable not only for its outcomes, but for its methods:
  - Speed: Did not take one hospital 64 years to amass the power of the study – it took 43 hospitals 18 months
  - Implementation: Not conducted by a single-purpose research team, but by nurses and infection prevention professionals during routine patient care
  - Setting: Did not occur in a controlled research unit, but within community hospitals across the country, embedded in routine care
  - Because of interoperable health information, REDUCE MRSA efficiently answered real-world questions, in real-world environments, that generalize to real-world situations
What Made REDUCE MRSA Possible?

**IT-Related Capabilities from Meaningful Use Investment:**

1. **Standard information platform**
   - Similar EHR system in every hospital (MU Stage 1)
   - Conventions to assure semantic interoperability (conceptual consistency)

2. **Aggregation of data into one repository**
   - n.b., Current work from enterprise clinical data warehouse

3. **Normalization of non-standardized data**

4. **Continuous data quality assessment and feedback**

5. **Analysis of aggregate data in situ assuring privacy & security**
   - i.e., Secure “sandbox” for analytics; no transmission beyond organization

The REDUCE MRSA Dividend . . .

HCA’s Standardized Infection Ratio for ICU Central Line-Associated Blood Stream Infection

![](chart.png)

**Universal Decolonization Phased In**

- **Q3 2012**
- **Q4 2012**
- **Q1 2013**
- **Q2 2013**
- **Q3 2013**

**42% Reduction (Q012 - Q013)**

Source: National Healthcare Safety Network (NHSN)

**The REDUCE MRSA Dividend . . .**

- **HCA’s Standardized Infection Ratio for ICU Central Line-Associated Blood Stream Infection**

**Standardized Infection Ratio**

- **Universal Decolonization Phased In**

**Universal Decolonization Phased In**

- **Q3 2012**
- **Q4 2012**
- **Q1 2013**
- **Q2 2013**
- **Q3 2013**

**42% Reduction (Q012 - Q013)**

Source: National Healthcare Safety Network (NHSN)

**What Made REDUCE MRSA Possible?**

- **Host Organization (HCA) Commitment to SAFETY (infection prevention, learning healthcare) and providing a platform**
- **Financial Investment:** High quality delivery science is very efficient, but not free. Belief in clinical, societal, scholarly & financial ROI
- **Partnership of public (CDC, AHRQ) and private sector (HCA) and academia (Harvard, UC Irvine, Washington University, Rush)**
- **Practical Methodology: Cluster-Randomization well-suited to pragmatic research & comparative effectiveness**
- **Patients contagious !**

**Interconnected, interoperable (EHR) health information**


**What Made REDUCE MRSA Possible?**

- **Study Design & Question:**
  - Large, two-arm, cluster randomized, pragmatic comparative-effectiveness trial in 50 HCA hospitals (~300,000 patients) to assess the value of chlorhexidine bathing and MRSA decolonization in adult patients on non-critical care units

- **Key Outcomes:**
  - Unit-associated acquisition of MDROs
  - Bloodstream infections: all pathogens

- **Additional Outcomes:**
  - Urinary tract infections: all pathogens
  - Contaminated blood cultures
  - Infectious readmissions: all pathogens
  - Emergence of resistance among key pathogens
  - Cost assessment

**Active BAthing To Eliminate (ABATE) Infection Trial**

- **Study Design & Question:**
  - Large, two-arm, cluster randomized, pragmatic comparative-effectiveness trial in 50 HCA hospitals (~300,000 patients) to assess the value of chlorhexidine bathing and MRSA decolonization in adult patients on non-critical care units

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**SWAPOUT**

- **Large, two-arm, cluster randomized, pragmatic comparative-effectiveness trial, beginning January, 2017**
  - **140 HCA hospitals (>1,000,000 patients)**

**Arm 1:**
- Chlorhexidine bath
- Mupurocin Nasal Tx

**Arm 2:**
- Chlorhexidine bath
- Iodophor
Are Learning Opportunities:
- Rare?
- Subtle?
- Esoteric?

Case Study 2: Billion Dollar Babies

Another Significant Question: When is Term Really "Term"?
37 to 39 weeks babies are generally robust, but is there a scientific basis to say they are equally robust within range?
- HCA, along with March of Dimes (MOD) and American College of Obstetricians and Gynecologists (ACOG) called the question
- Does contemporary clinical practice = optimal outcomes?

Preventing Adverse Neonatal Outcomes

- What we did:
  - Over a 90-day period, 27 hospitals collected outcomes for 17,794 deliveries
- What we found:
  - 37 ≠ 38 ≠ 39 weeks
    - Mortality
    - Lung immaturity, respiratory distress
    - Unstable vital, nutritional challenge
    - Social disruption of birth experience
  - Long-Term Morbidity
    - Developmental delays
  - Resource Utilization
    - Unnecessary NICU days
    - More post-discharge care
    - Lost work time for parents

Elective Term Delivery and NICU Admission*  

Transformative Clinical Leadership: Moving from Knowledge to Practice

Clinical Behavior Change:
- Trial 2:
  - Hard stop (Group 1)
  - Peer-review model (Group 2)
  - Clinical discussion (Group 3)
- Study demonstrated ‘hard stop’ yielded best results in reducing early, elective ‘pre-term’ delivery
- MoD, insurers and CMS now promoting preventing pre-term & ‘hard stop’ as a recommended practice

Learning / Improvement Opportunities

Learning opportunities are ubiquitous
Learning has to be intentional
- EHR’s don’t yet automate “pattern recognition” (i.e., relationship between gestational age, complications, type of complications and cost of potentially avoidable services)

Improvement also has to be intentional
- Must obligate to using evidence

Health behavior change has to be intentional
- Compelling data change discussion from religion to evidence

Beyond the preventable human toll, the cost-avoidance (if all babies in the U.S. covered under Medicaid were delivered using the best science to prevent "early elective delivery") would exceed $1 billion!
- Medicaid is payer for 40% babies in U.S.
  - Bigger is Better
    - A baby’s brain at 25 weeks weighs only two-thirds what it will weigh at 39 weeks.
  - Work featured as validation for CMS “Strong Start for Mothers & Newborns” CMMI Initiative
What If REDUCE MRSA Didn’t Require 18 Months?

What if the results of REDUCE MRSA — of the strategies compared — were already present in data generated by previous care?

• What if trials could have been performed “in silico?”
  • In 18 minutes, not 18 months? (REDUCE)
  • In 9 minutes, not 90 days? (Pre-term delivery)

What other answers to pressing questions (cost, quality, precision medicine, policy) might exist in the “collective memory” of our healthcare services?

How does healthcare harvest the “Data Dividend?”

Federal Health (CMS) Policy Agenda – From Volume to Value: Information Essential to Manage Care and Financial Risk

Progressive Risk:
• Fee-for-service
• Pay-for-performance
• Episode & Disease Management
• Population Risk

• As “risk” increases, information needs increase for care management and predictive analytics
• So, what can fragmented healthcare providers do??

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Harvest the “Digital Dividend”
Care Informs Care: A Learning Health System

Care Changes Care: An Improving Health System

Evolving Data Volume Exceeds Cognitive Capacity*


Enabling Movement from “Lumpers to Splitters”

Next Generation Performance: SEPSIS Improvement

Sepsis Mortality:

- #11 in U.S.
- #9 in Hospitals
- #3 in ICU
- #1 in non-cardiac ICU

Stop Severe Sepsis [_____] ~ 1,400 lives saved YOY

Early Detection [________] ???

Predicting Sepsis [_____] ???

Detecting & Predicting Sepsis Early [____] ???

Sepsis Survival Time

Evolving From Data Mining to Data Science . . .

Structured Data Business Intelligence

- How is the individual like the group?
- How does the group predict the individual?

Big Data Data Science

- Focus
- Aggregated transactions
- Individual transactions
- Group focus
- Individual focus
- Actuarial risk
- Individual risk
- Business intelligence
- Observation/Description
- Report on known signals
- Data science
- Prediction/Prescription
- Identify hidden signals

Beyond “Structured” Data: Cognitive Computing for Early Cancer Diagnosis using “Natural Language Processing”

- Benefits: Early Dx & Tx + Preventing “Missed Dx”
- Custom Mass Produced Personalized Care c. 2003 c. 2016

Report Card on U.S. EHR Information Superhighway

- Transition from paper to EHR? Yes
- End-to-End EHR Interoperability? Not yet
- Ability to support safer care? Generally
- Precision & Personalized Care? Evolving
- Bridge to managing risk / value? Alternatives?
- A Viable National Strategy? Context (paper, cell)
- Visibility into care for learning? Absolutely

The Return on HITECH: The “Data Dividend” Learning, Improvement and Value

A “Learning Health System”

A learning healthcare system is [one that] is designed to generate and apply the best evidence for the collaborative healthcare choices of each patient and provider; to drive the process of discovery as a natural outgrowth of patient care; and to ensure innovation, quality, safety, and value in health care [1].
The "Data Dividend"... a Learning & Improvement Engine

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Planned Research Portfolio – Selected Studies

<table>
<thead>
<tr>
<th>Project</th>
<th>HCA Contribution</th>
<th>Funder</th>
<th>Potential Impact</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. ABATE: Universal decolonization of patients not in ICUs</td>
<td>50 affiliated hospitals</td>
<td>NIH</td>
<td>Recommended new standard of care to prevent infections</td>
</tr>
<tr>
<td>2. INSPIRE: Develop and test materials and methods to improve empiric antimicrobial therapy</td>
<td>60 HCA hospitals</td>
<td>NIH</td>
<td>Reduce unnecessary and risky use of broad-spectrum antibiotics</td>
</tr>
<tr>
<td>3. SWAPOUT: Test iodophor nasal ointment as a component of ICU decolonization regimen</td>
<td>140 affiliated hospitals</td>
<td>CDC and Clorox</td>
<td>Improve the standard decolonization regimen by limiting risk of resistance to current agents</td>
</tr>
<tr>
<td>4. CLUSTER: Test impact of early detection on size of infection outbreaks in hospitals</td>
<td>80 hospitals</td>
<td>CDC</td>
<td>Allow hospitals to mount early response to outbreaks. Fully automated system reduces burden on staff</td>
</tr>
<tr>
<td>5. iMobile: Evaluate effect of secure messaging among hospital teams</td>
<td>15 hospitals</td>
<td>AHRQ</td>
<td>Improve patient outcomes through efficient communication</td>
</tr>
<tr>
<td>6. Sentinel System: Assess the safety of marketed medical products</td>
<td>All HCA hospitals</td>
<td>FDA</td>
<td>Improve national capability to identify risks of medications, biologics, and blood products</td>
</tr>
<tr>
<td>7. PAICAP: Assess ability of EHR data to monitor the impact of policies to prevent healthcare-associated infections</td>
<td>All HCA hospitals</td>
<td>AHRQ</td>
<td>Inform national policy regarding quality monitoring and payment incentive systems</td>
</tr>
</tbody>
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Bibliography


