Setting the Stage for Data Science in Healthcare: 
The (Big) Data Dividend of Meaningful Use

Digital Learning Collaborative
Leadership Consortium for Value & Science-Driven Health Care
National Academy of Medicine

Washington, DC – February 18, 2016

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Overview

1. Meaningful Use

2. Case-Study in Learning & Improving at-Scale
   - The REDUCE MRSA Trial

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

- An “Interstate Highway Program” for Health Information Technology
  - Envisioned Interoperable Electronic Health Records
- Offered Incentives to Eligible Hospitals & Providers (Doctors) to adopt Electronic Health Records over a rolling four year period to end NLT 2017
  - Over $30 BILLION in incentives have been distributed
  - BTW, 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 Learning Health System – 2007 IOM Definition . . .

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].

Crossing the Digital Divide . . .

Hospitals Receiving Incentive Payments for Electronic Health Record Adoption or Meaningful Use (Quick-Stat 18)

May 2011

December 2013

Hospitals have adopted and used Electronic Health Records (EHR) at a rapid rate across the country since the inception of the CMS EHR Incentive Program. 4,400 hospitals or 87 percent of all U.S. hospitals had received at least one incentive payment from the Medicare or Medicaid programs, as of December 2013. View the Quick-Stat
Hospitals attested to stage 1 MU by size/type/location and 2014 edition certification status of primary vendor

Tide is raising all boats

Vendor has 2011 edition product(s) only
Vendor has 2014 edition product(s) not meeting Base EHR definition
Vendor has 2014 edition product(s) meeting Base EHR definition

Health IT Standards Committee / ONC, Nov 13, 2013
Note: Primary EHR vendors are the vendors whose products are certified to the most 2011 Edition certification criteria in the provider’s EHR system (in cases where a provider used certified products from multiple vendors to attest).
Sources: ONC Certified HIT Products List (CHPL) (10/21/2013), CMS Attestation Data (9/30/2013).
Crossing the Digital Divide . . . Physician Practices

Percent of Physicians e-Prescribing through an Electronic Health Record (Quick-Stat 17)

In the past five years, physician Electronic Health Record (EHR) adoption has surged, reaching all corners of the country. The percentage of physicians e-Prescribing via an EHR has accelerated from 7 percent in December 2008 to 66 percent as
The Data Dividend: Learning Healthcare

* ONC (http://dashboard.healthit.gov/quickstats/quickstats.php)
The Data Dividend: Learning Healthcare

Creating Data

Creating Knowledge
Tapping the “Collective Memory” Of Health Care Services

Advanced Analytics
Decision Support
EHR Use
Data Generation
When do we get to a system in which learning healthcare supports continuous quality improvement?

... Richard Kronick, Ph.D., Director, AHRQ
Institute of Medicine, March 18, 2015

2. Case-Study in Data, Learning & Improving at-Scale
   – The REDUCE MRSA Trial

3. Realizing The (Big) “Data Dividend”
Addressing a Significant Problem:

- In the United States, ~1 in 20 patients hospitalized will develop a healthcare-associated infection (HAIs)
  - ~1.9 – 2.1 million patients infected
  - ~80,000 die
  - ~$20-30 billion avoidable healthcare expenditures

- Methicillin-resistant *Staphylococcus aureus* (MRSA), and other *Staphylococcus aureus*, account for approximately 25% of all deaths from HAIs

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Could MU 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 (*n.b.*, mandated by law in 9 states)
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>
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<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 = 26,024</td>
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As Treated

| 16 Hospitals N = 23,480 | 13 Hospitals N = 22,105 | 13 Hospitals N = 26,024 |

1 Hospital (2 ICUs) withdraws

Aggregate: 43 Hospitals; 74,356 patients; 282,803 patient-days
REDUCE MRSA – Cluster-Randomized Trial Design
Answering Questions Across Multiple Institutions

Arm 2
Universal Decolonization

Arm 3
Targeted Decolonization

ICU Admissions
- <1000
- 1000-3000
- 3001-5000
- 5001-10000
REDUCE MRSA: Results (All Pathogen Bloodstream Infection)

Overall: $P < 0.0001$

Arm 2 vs 1: $P = 0.04$

Arm 3 vs 1: $P < 0.0001$

Arm 3 vs 2: $P = 0.003$
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: Study Findings

The NEW ENGLAND JOURNAL of MEDICINE

Targeted versus Universal Decolonization to Prevent ICU Infection

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and the AHRQ DECIDE Net

- Agency for Healthcare Research and Quality
- CDC Prevention Epicenters Steering Committee
- Harvard Pilgrim Health Care Institute / Harvard Medical School
- Hospital Corporation of America
- Rush University
- University of California Irvine

HCA | AHRQ | CDC | HCA Clinical Services Group
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
Major Outcomes in High-Risk Hypertensive Patients Randomized to Angiotensin-Converting Enzyme Inhibitor or Calcium Channel Blocker vs Diuretic The Antihypertensive and Lipid-Lowering Treatment to Prevent Heart Attack Trial (ALLHAT) [FREE]

The ALLHAT Officers and Coordinators for the ALLHAT Collaborative Research Group

[+] Author Affiliations


ABSTRACT | METHODS | RESULTS | COMMENT | REFERENCES

• **Size:** 33,000 Patients (vs. 75,000)
• **Efficiency:** ALLHAT $80M (vs. $3M, including supplies)
• **Length of Study:** 10 years (vs. 1½ years)

**Context** Antihypertensive therapy is well established to reduce hypertension-related morbidity and mortality in the general hypertensive population, but its efficacy in high-risk subgroups is unknown.

**Objective** To determine whether treatment with a calcium channel blocker or an angiotensin-converting enzyme inhibitor lowers the incidence of cardiovascular disease (CVD) or other cardiovascular disease (CVD) events vs treatment with a diuretic.

**Design** The Antihypertensive and Lipid-Lowering Treatment to Prevent Heart Attack Trial (ALLHAT), a randomized, double-blind, double-dummy, controlled clinical trial, was conducted from January 1994 through March 2002.

**Setting and Participants** A total of 33,357 participants aged 55 years or older with hypertension and at least 1 other CHD risk factor from 623 North American centers.

**Interventions** Participants were randomly assigned to receive chlorthalidone, 12.5 to 25 mg/d (n = 15,255); amlodipine, 2.5 to 10 mg/d (n = 9,048); or lisinopril, 10 to 40 mg/d (n = 9,054) for planned follow-up of approximately 4 to 8 years.
REDUCE MRSA: Discussion
Fostering a Learning Health System

• What made the REDUCE MRSA Study Possible?
  • **Partnership** of public (CDC, AHRQ) and private sector (HCA) and academia (Harvard, UC Irvine, Washington University, Rush)
  • **Host Organization** (HCA) **Commitment** to infection prevention, learning healthcare, and providing a platform
    • CDC, HPHCI had approached HCA because of MRSA ABC’s work*
    • Contribution of logistical and organizational resources
  • **Financial Investment**: High quality delivery science is very efficient, but not free. Belief in clinical, societal, scholarly & financial ROI
  • **Randomization** sometimes necessary, and cluster randomization well suited to pragmatic research & comparative effectiveness
  • **Interconnected, interoperable** (EHR) health information

REDUCE MRSA: Discussion
Fostering a Learning Health System

IT-Related Capabilities from Meaningful Use Investment:

1. Standard information platform
   • Same 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

Source: National Healthcare Safety Network (NHSN)
Learning Health Opportunities

Learning opportunities are ubiquitous

Organizational learning has to be intentional

• Improved data systems
  – Detecting rare events
  – Detecting subtle, yet frequent events

Organizational improvement also has to be intentional

• Must obligate to using evidence
• Clinical behavior change (provider and patient) is an additional step
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 silica?”
- In 18 minutes, not 18 months?

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

How do we harvest the “Data Dividend?”?
Care Informs Care: A Learning Health System

What Could be Brought Back to the Care of a Patient?

Myonecrosis: Is a bacterial infection that produces gas…

Brown Recluse Spider Bite: Spider bites, especially those of the…

Watson Confidence Watson Confidence Watson Confidence Watson Confidence N/A Watson Confidence Watson Confidence Watson Confidence

Necrotizing fasciitis: Is a serious bacterial infection that spreads…

Sweet’s syndrome: The eponym for acute febrile neutrophilic…

Abscess: An abscess is a collection of pus in any part of the body that…

Endocarditis: Is an infection of the inner lining of your heart…

Calciphylaxis: (kal-sih-fuh-LACK-sis) is a serious, uncommon…

* Modified from: Amazon.com
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.

• 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

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What Could be Learned from the “Digital Dividend?”

Data sizes:
- US Library of Congress printed material: 10 Tb
- HCA: 120 Petabytes (12,000 Libraries of Congress)
- Google: Best Guess 15 Exabytes
  (1.5 million Libraries of Congress, 100x HCA)

Planet volumes:
- Moon: 2.2E-2
- Jupiter: 1.4e3 (63,000 moons)
- Sun 1.4E6 (63 million moons)

Units:
- Exabyte: 10^18 bytes
- Petabyte: 10^15 bytes
- Terabyte: 10^12 bytes
- Gigabyte: 10^9 bytes

Note that the Library of Congress has at least 3 petabytes of digital content.
The “Data Dividend”
... a Learning & Improvement Engine


Platt R, Huang SS, Perlin JB. “A Win for the Learning Health System.” May 29, 2013. Commentary, Institute of Medicine, Washington, DC. Available at [http://www.iom.edu/WinforLHS](http://www.iom.edu/WinforLHS);

