Adding value to Healthcare with Big Data

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Introduction. Concepts and Scenarios
An Epidemiological Model for Health Policy Analysis. A new Paradigm?
Dever GEV. 1976

Impact on total mortality:
- Healthcare services: 11%
- Lifestyle: 43%
- Environment: 19%
- Human Biology: 27%

Health expenditures:
- Healthcare services: 89.9%
- Lifestyle: 1.5%
- Environment: 1.6%
- Human Biology: 7%
Value-based Healthcare Requires a 360° View of the Individual

- Genetics
- Omics Data
- Environment, Diet, Lifestyle, and Exercise
- Therapy Adherence
- Electronic Health Information
Big Data Healthcare Background

• **Value-driven healthcare and fiscal concerns:**
  – Population health
  – Pay for Performance and Outcomes Management
  – Risk Sharing Contracts

• **Open Data Movement:**
  – Open government
  – Clinical Trials Scrutiny
  – Ehealth fast adoption and interoperability

• **Consumer-driven healthcare:**
  – Mhealth and wearable devices
  – Personal Health Records
  – Social Media and Networks
  – Smart cities and Internet of Things

• **The Omics Revolution:**
  – Personalized Medicine
  – Translational Research
  – Real-World Evidence
Analytics Are Vital to Healthcare Industry Transformation

Today

High Value

Low Value

Low Use of Analytics

High Use of Analytics

Core Clinical and Operational Systems

Enterprise Data Integration

Analytics Applications

Trial and Error Medicine

Evidence-Based Medicine

Value-Based Medicine

The “Learning Healthcare Organization”

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What Makes it Big Data?

MIT definition: The management and use (efficient storage, search, analysis and visualization) of ultra-large amounts (more than 1 Petabyte) of information
In the Coming Decade Healthcare Data Will Be Big, Real Big

Circle Area Suggests the Relative Volume of Healthcare-Relevant Data on a Given Person

+ EMR
+ HIE
+ PHR
+ Social
+ Omics
+ Sensor
## Volume in Healthcare

<table>
<thead>
<tr>
<th>Volume</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>5 Megabytes ($10^6$ bytes)</td>
<td>Complete printed works of Shakespeare</td>
</tr>
<tr>
<td>4 Gigabytes ($10^9$ bytes)</td>
<td>One patient’s medical record (incl. images)</td>
</tr>
<tr>
<td>10 Terabytes ($10^{12}$ bytes)</td>
<td>Printed works in the Library of Congress</td>
</tr>
<tr>
<td>400 Terabytes ($10^{12}$ bytes)</td>
<td>Data growing p.a. at UPMC (University of Pittsburgh Medical Center)</td>
</tr>
<tr>
<td>2 Petabytes ($10^{15}$ bytes)</td>
<td>Google Earth information managed today</td>
</tr>
<tr>
<td>15 Petabytes ($10^{15}$ bytes)</td>
<td>Growth of US HC data per day</td>
</tr>
<tr>
<td>30 Petabytes ($10^{15}$ bytes)</td>
<td>Volume of HC data managed by Kaiser Permanente</td>
</tr>
<tr>
<td>~10 Exabytes ($10^{18}$ bytes)</td>
<td>Estimated size of current US digitized patient data</td>
</tr>
</tbody>
</table>

We generate as much data in two days as since dawn of man through 2003
Velocity in Healthcare

- Driven by real-time data creation, data is continually being generated at a pace that is impossible for traditional systems to capture, store and analyze.
- Need to incorporate streaming data into business processes and decision making.
- For time-sensitive processes such as home monitoring alerts or real-time fraud detection, certain types of data must be analyzed in real time to be of value to the business.

In 5 years consumer driven HC will be the major eHealth data source
Variety in Healthcare

- **Administrative**
  - At patient level: Identification, demographics, diagnosis, etc.
  - At provider level: Procedures, costs, charges, payments

- **Clinical / Electronic Medical Records**
  - Lab test results, prescriptions, pathology reports, clinician notes, etc.

- **External Sources**
  - Research, pharmacy, government, population, other providers

- **Medical Device / Machine-Generated**
  - Blood pressure, heart rate, glucose levels, weight, etc.

- **Imaging & Diagnostics**
  - X-ray, CT, MRI

- **Customer Experience**
  - Web, Call Center, Social Media

- **“Omics”**
  - Genomics, Proteomics, Metabolomics

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Up to 80% of current HC data is unstructured and stored in silos
Analytics: More Than Meets the Eye

Data analysis and presentation is the relatively EASY PART

Data acquisition from myriad complex clinical, financial, administrative, and research source systems and the attendant cleansing, integration, and warehousing of these data is the HARD PART
Big Data driven innovation may save $300-450 billion (12-17%) of US health care costs

McKinsey&Company
Use Cases
Big Data In Health Care: Using Analytics To Identify And Manage High-Risk And High-Cost Patients

Health Aff July 2014 vol. 33 no. 7 1123-1131

Six use cases:

1. Cost patients
2. Readmissions
3. Triage
4. Decompensation
5. Adverse events
6. Treatment optimization for diseases affecting multiple organ systems
Use Case Scenarios

Research & Development

(Omics) Data Management

Individualized Treatments / Personalized Medicine

Predictive Modeling/ Clinical Trial Design

Provider Setting

Data Analysis & Clinical Protocols

Telemonitoring & -health

Social Interactions

Payers & System Level

Outcome Base Compensation

Population Health, national EHR

Behavioral Modification/ Prevention

Value is always related to a proper analysis of the data.
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Translational Research

On the path to Personalized Medicine

Ability to discover high quality biomarkers which in turn will enable early detection, rapid effective treatment and improved quality of care for patients with considerable associated cost savings (“right treatment for the right patient”)
Identifying Relationships between Gene to Cancer Interaction

• Analyzed 20 million medical publication abstracts

• Cross-referenced relationships between 17,000 genes and five major cancer types

• Cross-referenced genes from 60 million patients and miRNA for a simulated 900 million population

• Results
  - Understanding additional layers of the pathways these genes operate
  - Understand the drugs that target them
  - Help researchers accelerate their work
“Our mouths were open in amazement”

– Dr. Robert Stephens, Director of Bioinformatics, National Cancer Institute
Pfizer – Clinical Aggregation Layer (CAL)

**Oracle**
- Oracle Hosted
- Oracle LSH and CDA
- Oracle FMW and OBI
- Exadata

**Accenture**
- Design
- Build
- Manage

Detailed information [here](#)
• Crizotinib (trading name: Xalkori) specifically targets the ALK protein which is mutated in 7% of lung cancers and is the primary driver in these cancers.
• Pfizer received FDA approval based on a trial of only 255 patients with the biomarker.
• From discovery of the mutation in 2007 to approval of drug in 2010 took just 3 years.
Personalized Medicine by the Numbers

34% reduction in chemotherapy use would occur if women with breast cancer receive a genetic test of their tumor prior to treatment.

17,000 strokes could be prevented each year if a genetic test is used to properly dose the blood thinner warfarin.

$604M in annual health savings would be realized if patients with metastatic colorectal cancer receive a genetic test for the KRAS gene prior to treatment.

Source: Personalized Medicine Coalition
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Some questions a provider might seek answers for

• What is the correlation between the length of acute respiratory infection and the administered doses of different antibiotics?

• How is compliance with treatment plans?

• How do specific Hospital system members perform compared to their peers?

• Which patient and institutional factors best predict higher hospital readmission rates?

• What is the cost of treating those infections relative to the specific antibiotics prescribed?
Customer Example

**Project**
- Using near real time clinical data
- Easy to understand, personalized metrics
- Patient engagement including social media/collaboration
- For >1m patients, many rural, served by local community health workers/coaches
- Innovative outcomes-based reimbursement

**Results**
- Earlier intervention
- Improved patient compliance
- Avoided hospitalizations
- 277% annual ROI

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Facebook for Medicine: Know your Colors

Predict a patient’s average monthly cost
Predict risk for high-cost care
Identify most effective providers
For the next-generation of treatments we require a powerful analytical infrastructure that can yield new insight from the unprecedented volume of data available today.

*John Frenzel, Chief Medical Information Officer*

We need to leverage data and information to drive more effective resource utilization, improve operational efficiency, and level patient volumes.

*Craig Owen, Director of Clinical Analytics and Informatics*
Analysis for Actionable Items

**Business Objectives/Issues**

**Gain Insights**

**Take Action**

**ROI**

**Pharmacy Staffing**

Ensure efficient use of Pharmacy resources

Is Pharmacist overtime higher than expected?

What is order volume per hour?

What is Pharmacist staffing by hour?

Adjust Pharmacist start to align with AM order time

~$300k staffing savings

**Formulary Analytics**

Efficiently Manage Formulary

Analyse Formulary with Custom Dashboard

501 individual drugs analysed

Identified 11 new class review opportunities

Eliminated 11 duplicative drugs

$20k / drug eliminated

**Drug Class Analytics**

Optimize Formulary on Cost / Efficacy

Analyse Echinocandin Antifungal Drug Class

Compare Ordering Patterns & Cost

Analysed Outcomes

Eliminated 2 of 3 agents

~$500k / year
Customer Example

**NHS BSA**
- Responsible for a third of the NHS budget
- Manages prescription reimbursement
- Delivery of supply chain services to the NHS
- NHS Pensions

**Challenges**
- 4 million prescriptions processed/day
- 30%+ entered manually
- Need to find drugs misuse and fraud & error
- Unable to monitor best practice (drug administration versus outcomes at national level)
- Inability to link structured and unstructured data together
Identify Fraud and Drive Policies

Unique feature: Free text analysis (social media, physician notes)
Use Case Scenarios

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Norway’s „Kjernejournal“

National Electronic Health Record

Challenges

• Customer’s role is to improve the health of the nation through integrated and targeted cross-sector activities.

• Main goal of project is to ensure secure and simple information flows in HC, without information being disclosed to unauthorized third parties.

• Therefore a National Electronic Health Record (EHR) for all 5m Norwegian citizens was created. For this system, they were looking for a fully-functional, easily interoperable, highly resilient, secure, and scalable platform.
Norway’s „Kjernejournal“

National Electronic Health Record

Challenges

• National electronic health record
  – Administrative data
  – Doctors and hospital encounters
  – Medication
  – Serious allergies, hypersensitive reactions, implants, etc.
  – Data entered/authorized by the patient

• Can be created, managed, and consulted by authorized clinicians and staff

• Conforms to nationally recognized interoperability standards
Oracle Health Sciences Network

Secure HIPAA-Certified, Cloud-Based Collaboration for Clinical R&D

Life Sciences Participants

Healthcare Provider Participants

Near Real-Time Clinical Data

Protocol Feasibility / Validation and Patient Recruitment

De-Identified Data

Alerts

Protocols
Concluding
Big Data Helps to Solve Challenges

Across the whole HC ecosystem which were not addressable before

- Increased R&D Productivity
- Improved Quality & Safety
- Participatory & Preventive Care
- Personalized Medicine
- Personalized Care
... But There Are Still Hurdles to Overcome

1. Legal framework for data sharing
2. Lack of trust and reluctance to share data
3. Technological challenges: reliability and structure of data
4. Structural challenges: Lack of multidisciplinary experts
5. Lack of robust business models
Success factors

1. Don’t overrate technology its about implementation;
2. Start where there is tangible value
3. Big data in HC is not only about cost savings
4. Value comes from integration
5. Develop Analytical capabilities to improve costs, value and coordination of care
6. Ensure trust
7. Data security is important, but take a smart approach
Additional Readings

• Health Affairs July 2014. Bates DW et al.: Big Data In Health Care: Using Analytics To Identify And Manage High-Risk And High-Cost Patients (Link)

• Gartner: Customer Experience Increasingly the Focus of Big Data Projects (Link)

• McKinsey Study: The big-data revolution in US health care: Accelerating value and innovation (Link)

• The Boston Consulting Group: Making Big Data Work: Health Care Payers and Providers (Link)

• EMC: The Big Data Cure (Link)

• Accenture: Insurers are getting business benefit out of their big data projects (Link)