PANEL

BIG DATA: THE NEXT FRONTIER

Moderator: Lindsay Kislock
Assistant Deputy Minister of Health, Province of British Columbia

Speakers:

Dr. Tom Karson, M.D., Principal
Accenture Healthcare Solutions and Analytics

Julie Lockner, Vice President
Information Life Cycle Management BU, Informatica

Rachel Debes, Research Associate
Infectious Disease Insights, Cerner Corporation
BIG DATA: The New Frontier

Dr. Tom Karson, M.D., Principal Accenture Healthcare Solutions and Analytics

June 18, 2012
WHAT’S THE DEFINITION OF BIG DATA?
BIG DATA: “Classic Definition”

The 3 Dimensions of “Big Data:”

1. Increasing **Volume** (amount of data)
2. **Velocity** (speed of data in and out)
3. **Variety** (range of data types and sources)

2001 research report and related conference presentations, META Group (now Gartner), Doug Laney (2001)
So, Is This Big Data?...
Increasing Volume: The Zettabyte Era

A zettabyte (ZB) is equal to one sextillion bytes

• 1,000,000,000,000,000,000,000 bytes = 1000^7 bytes = 10^{21} bytes
• As of April 2012 no storage system has achieved one zettabyte of information
• The combined space of all computer hard drives in the world was estimated at approximately 160 exabytes in 2006
• As of 2009, the entire World Wide Web was estimated to contain close to 500 exabytes. This is a half zettabyte

Comparisons to understand scale in context

• A zettabyte is equal to 1 billion terabytes
• The world’s technological capacity to receive information through one-way broadcast networks was 0.432 zettabytes of (optimally compressed) information in 1986, 0.715 in 1993, 1.2 in 2000, and 1.9 (optimally compressed) zettabytes in 2007 (this is the informational equivalent to every person on earth receiving 174 newspapers per day)
• According to International Data Corporation, the total amount of global data is expected to grow to 2.7 zettabytes during 2012. This is 48% up from 2011
• Research from the University of California, San Diego reports that in 2008, Americans consumed 3.6 zettabytes of information
Or, Is This Big Data?...

Increasing Velocity: The Supercomputer
US National Nuclear Security Administration uses Sequoia to research the safety, security and reliability of nuclear deterrent – replacing the need for underground testing

- Sequoia consists of 96 racks; 98,304 compute nodes,
- 1.6 million cores
- 1.6 petabytes of memory, and hit an impressive of
- 16.32 Petaflops—quadrillions of computations per second (a new record)
  - A quadrillion is one thousand million million
- Most energy efficient supercomputer as well
Or, Is This Big Data?...

Variety of Data: Range of Data Types
Epigenetic Mechanisms in Human Health and Disease

Variety of Data: Range of Data Sources

- Chemical agents
- Biologic agents
- Nutrition
- Stress

- Development/aging
- Cancer
- Neurodegenerative disease
- Behavioral/cognitive disease

- Gene activation
- Gene silencing
- Chromosome instability
- Chromatin remodeling

ENVIRONMENTAL EXPOSURE

GENES

GXE

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DNA-management through Epigenetic Marks.

Chromosome

Since 2002, particularly the last two years, biologists have turned to studying the epigenetic marks which represent an addition to the genetic templates without changing the DNA nucleotide sequences, but these are carried through to the next generations. Many types of epigenetic processes have been identified—they include methylation, acetylation, phosphorylation, ubiquitylation, and sumoylation, but of these the best known is DNA methylation. The epigenetic marks are natural in may DNA-expressions, but if these marks are wrong they can have very serious health and behavioral effects.

DNA double helix staircase:
The sides of the DNA-staircase are sugar-phosphate and the "step" are composed from four kinds of nucleotides: Cytosine + Guanine and Thymine + Adenine. The nucleotide pairs form the steps, but they are known as the two "DNA-bases"; C + G and T + A.
WHAT’S THE DEFINITION OF BIG DATA?

WHO CARES?!
IT’S NOT ABOUT THE DATA...

IT IS ABOUT WHAT YOU DO WITH IT!
Use Big Data to Find Cause and Effect
Use Big Data to Put the Pieces Together

Clinical Data Transformation

The result allows clinical analytics to be performed
Clinical insight can be gained by creating clinical data use cases so that data repositories can satisfy the long term data needs of each opportunity for greater insight and improvement.

**Clinical Data Use Cases**

- Care Management
- Quality Measurement
- Clinical Process Improvement
- Clinical Effectiveness & Outcomes Analysis
- Member / Patient Engagement
- Telemedicine / Remote Monitoring
- Data Integration
- Clinical Terminology
The Data Needed to Empower Health Analytics Is Distributed Throughout the Ecosystem

Patient insight based on both historical and current data is the critical common denominator.
THE ANALYTIC JOURNEY
The Analytics Maturity of an Organization Can Be Defined Using the “DELTA” Model

Data: breadth, integration, quality
Enterprise: approach to managing analytics
Leadership: passion and commitment
Targets: first deep, then broad
Analysts: professionals and amateurs

The Analytics Maturity Model evaluates 5 capabilities
Improved analytics capabilities are achieved by making improvements to one’s DELTA
## The Five Stages of the DELTA Model

<table>
<thead>
<tr>
<th>Stage 1: Analytical Novice</th>
<th>Stage 2: Localized Analytics</th>
<th>Stage 3: Analytical Aspirations</th>
<th>Stage 4: Analytical Companies</th>
<th>Stage 5: Analytical Competitors</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Data</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>- Inconsistent, poor quality &amp; organization of data</td>
<td>- Much data usable</td>
<td>- Identifying key data domains and creating central data repositories</td>
<td>- Integrated, accurate, common data in central warehouse; data still mainly an IT matter; little unique data</td>
<td>- Relentless search for new data and metrics</td>
</tr>
<tr>
<td>- Difficult to do substantial analysis</td>
<td>- Functional/process silos</td>
<td>- Analytics emerging as enterprise priority</td>
<td>- Few embedded processes</td>
<td>- Organization separate from IT oversees info</td>
</tr>
<tr>
<td>- No groups with strong data orientation</td>
<td>- Limited data management</td>
<td>- Process/BU unit focus</td>
<td>- Few embedded processes</td>
<td>- Data as strategic asset</td>
</tr>
<tr>
<td>- Isolated analytic efforts, un-integrated data; disconnected processes</td>
<td>- Islands of data, technology, and expertise deliver local value</td>
<td>- Analytics infrastructure beginning to coalesce</td>
<td>- Key data, technology and analysts managed from an enterprise perspective</td>
<td>- Fully integrated processes</td>
</tr>
<tr>
<td><strong>Enterprise &amp; Organization</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>- Analytics not a strategic priority</td>
<td>- Analytics is functional priority; narrow focus</td>
<td>- Key data, technology and analysts managed from an enterprise perspective</td>
<td>- Senior leaders developing analytical plans and building analytical capabilities</td>
<td>- Key analytical resources focused on enterprise priorities &amp; differentiation</td>
</tr>
<tr>
<td>- No enterprise perspective on data or analytics</td>
<td>- Islands of data, technology, and expertise deliver local value</td>
<td>- BI governance</td>
<td>- Senior leaders developing analytical plans and building analytical capabilities</td>
<td>- Enterprise-wide BA/BI architecture implemented</td>
</tr>
<tr>
<td>- Poorly integrated systems</td>
<td>- Local leaders emerge, but have little connection</td>
<td>- Executive support for fact-based culture</td>
<td>- Fact-based, data driven culture</td>
<td>- Strong leaders behaving analytically; Passion for analytical competition</td>
</tr>
<tr>
<td><strong>Leadership &amp; Culture</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>- Little awareness of or interest in analytics</td>
<td>- Desire for more objective data; success stories</td>
<td>- Awareness of competitive possibilities</td>
<td>- Broad C-suite support</td>
<td>- Broad support for fact-based/testing/learning culture</td>
</tr>
<tr>
<td>- Functional &amp; tactical sponsors</td>
<td>- Executive support for fact-based culture</td>
<td>- Analytics centered on a few key business domains with explicit and ambitious outcomes</td>
<td>- Analytics centered on a few key business domains with explicit and ambitious outcomes</td>
<td>- Strong commitment</td>
</tr>
<tr>
<td>- Intuition-based decisions; knowledge averse</td>
<td>- Senior leaders recognize importance of analytics / developing capabilities</td>
<td>- Broad C-suite support</td>
<td>- Analytics centered on a few key business domains with explicit and ambitious outcomes</td>
<td>- Analytics integral to the company’s distinctive capability and strategy</td>
</tr>
<tr>
<td><strong>Targets</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>- No targeting of opportunities</td>
<td>- Multiple disconnected targets, typically not of strategic importance</td>
<td>- Analytical efforts coalescing behind small set of important targets</td>
<td>- Analytical efforts coalescing behind small set of important targets</td>
<td>- World-class professional analysts; cultivation of analytical amateurs across the enterprise</td>
</tr>
<tr>
<td><strong>Analytical Talent</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>- Few analytical skills or roles</td>
<td>- Unconnected pockets of analysts</td>
<td>- Analysts recognized as key talent and focused on important business areas</td>
<td>- Highly capable analysts explicitly recruited, developed, deployed, and engaged</td>
<td>- World-class professional analysts; cultivation of analytical amateurs across the enterprise</td>
</tr>
<tr>
<td>- Attached to specific functions</td>
<td>- Unmanaged mix of skills</td>
<td>- Limited interaction</td>
<td>- Highly capable analysts explicitly recruited, developed, deployed, and engaged</td>
<td>- World-class professional analysts; cultivation of analytical amateurs across the enterprise</td>
</tr>
</tbody>
</table>
The Analytics Progression

- **Optimization**
  - “What's the best that can happen?”

- **Predictive Modeling**
  - “What will happen next?”

- **Forecasting/extrapolation**
  - “What if these trends continue?”

- **Statistical analysis**
  - “Why is this happening?”

- **Alerts**
  - “What actions are needed?”

- **Query/drill down**
  - “What exactly is the problem?”

- **Ad hoc reports**
  - “How many, how often, where?”

- **Standard Reports**
  - “What happened?”

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Source: Competing on Analytics: The New Science of Winning (Davenport / Harris)
In General, the Health Care Industry Lags Behind Other Industries in Use of Analytics

**Analytics Landscape by Industry**

- Predictive
- Descriptive

Majority of healthcare is in bottom left corner

**Resource Capabilities**
- People
- Data
- Funding
- Skill Set

**Sophistication of Product & Service**
- Low
- High

**leading US Health Providers**
- Ontario Healthcare
- US Healthcare
- Leading US Health Providers

**ILLUSTRATIVE**
- Banking - Barclays Bank
- Consumer - P&G
- Pharma - AstraZeneca
- Retail - Walmart
- Internet - Amazon
- Gambling - Harrah’s

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For Healthcare Organizations to Progress There Are Areas That Need to Evolve and Be Managed

• Governance
  – There is a spectrum of governance models that is right for a given organization based on its analytics maturity and environmental context
  – The appropriate model will allocate responsibility for data across those who use (own) the data and those who manage the data

• Skills and Talent Management
  – Leading organizations have talent management processes to define, discover, develop, and deploy analytic resources within the organization
  – Refining and/or expanding organizational skills requires planning and coordination to recruit and nurture resources

• Processes
  – Organizations re-organize processes to collect and analyze data, generate insights, and communicate results
  – Data becomes actionable
...and Analytics needs to bring value to the data

Statistical Analysis
- Root Cause Analysis
- Link Analysis
- Segmentation
- Text Mining

Optimization
- Operations Research

Modeling and Scoring
- Propensity Analysis

Forecasting
- Econometric Forecasting
IMPORTANT
Data is needed for:

• Providers on the front lines of medical care
• Healthcare officials managing the health of a population
HOW IS CANADA DOING?
Accenture Research Performed a Multinational Study Looking at a Wide Array of Data Sources

8 Countries
- Canada
- USA
- Germany
- England
- France
- Spain
- Germany
- France

160 Healthcare experts Interviewed

3700 Physicians surveyed

10 In-depth case studies
- Indiana HIE
- Intermountain Healthcare
- Denmark
- Hong Kong
- Kaiser Permanente
- Lombardia Region
- Singapore’s National EMR
- Midi-Pyrénées, France
- Scotland
- Madrid, Spain
- Singapore

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17 Key Functionalities Identified for: Healthcare IT Adoption, Health Information Exchange and Insights from Patients and Analytics

The functionalities of connected health

**Connected clinical practice**
- Hospitals/physician offices use electronic tools to reduce the administrative burden of health care delivery (e.g. e-scheduling or e-billing)
- Physicians capture patient data electronically
- Physicians receive electronic alerts/reminders while seeing patients (e.g. prompts regarding contraindications or preventative care)
- Physicians use clinical decision support systems (CDSS) to help make correct diagnostic treatment decisions at the point of care

**Connected to clinical practitioners in other organizations**
- Physicians communicate electronically with clinicians in other organizations (e.g. via secure email)
- Physicians are notified electronically of patients’ interactions with other health organizations (e.g. admission to hospital)
- Physicians send or receive referrals electronically to/from health professionals in other organizations (e.g. for specialist appointments)
- Physicians electronically access clinical data about a patient who has been seen by a different health organization (e.g. hospital, laboratory)
- Physicians send prescriptions electronically to pharmacies (e-prescribing)
- Physicians send order requests electronically (e.g. for tests)
- Physicians receive clinical results electronically that populate patients’ electronic medical records

**Connected to patients**
- Patients can book/change/cancel appointments with their physicians online
- Patients can communicate with their physicians electronically via secure email or video conferencing
- Patients can electronically access their own medical information (e.g. lab results, medications, imaging results, etc)
- Patients can monitor and record their own health indicators and share information with their physicians or with other approved clinicians

**Connected to analytics**
- Healthcare organizations capture and analyze care data and use this to identify needs for improvement in clinical care protocols and clinical outcomes across the organization
- Public health agencies use system-wide clinical data for population health reporting, allowing them to carry out analysis to monitor trends and manage disease in the population
Connected Health Maturity Index Is Based on Physicians’ Use of Both Healthcare IT and HIE Functionalities

Connected health maturity index: primary care vs. secondary/specialist care

- Primary care
- Secondary/specialist care

![Graph showing health information exchange and healthcare IT adoption and use for different countries.](image-url)
### Findings

#### Stage 1: Healthcare IT adoption

<table>
<thead>
<tr>
<th>Ability to generate registries and quality of care data</th>
<th>Australia</th>
<th>Canada</th>
<th>England</th>
<th>France</th>
<th>Germany</th>
<th>Singapore</th>
<th>Spain</th>
<th>US</th>
<th>Survey Average</th>
</tr>
</thead>
<tbody>
<tr>
<td>List of medications taken by patients (including those prescribed by other doctors)</td>
<td>59.7%</td>
<td>48.4%</td>
<td>65.5%</td>
<td>56.4%</td>
<td>64.3%</td>
<td>69.6%</td>
<td>74.7%</td>
<td>65.3%</td>
<td>62.5%</td>
</tr>
<tr>
<td>Lists of patients by specific condition/diagnosis</td>
<td>60.9%</td>
<td>42.2%</td>
<td>67.1%</td>
<td>46.2%</td>
<td>75.2%</td>
<td>61.8%</td>
<td>58.3%</td>
<td>57.4%</td>
<td>58.4%</td>
</tr>
<tr>
<td>List of patients by lab result</td>
<td>47.7%</td>
<td>35.2%</td>
<td>61.2%</td>
<td>30.7%</td>
<td>55.0%</td>
<td>59.8%</td>
<td>41.5%</td>
<td>42.4%</td>
<td>45.7%</td>
</tr>
<tr>
<td>Lists of patients who are due for tests (e.g. mammogram) or preventative care (e.g. vaccinations)</td>
<td>44.9%</td>
<td>24.2%</td>
<td>54.9%</td>
<td>31.5%</td>
<td>62.1%</td>
<td>59.3%</td>
<td>49.3%</td>
<td>40.6%</td>
<td>44.8%</td>
</tr>
<tr>
<td>Data relating to clinical quality of care measures</td>
<td>31.7%</td>
<td>18.2%</td>
<td>56.7%</td>
<td>21.3%</td>
<td>30.4%</td>
<td>52.0%</td>
<td>31.5%</td>
<td>42.4%</td>
<td>34.3%</td>
</tr>
</tbody>
</table>

N=3727
# Findings

## Stage 2: Health information Exchange

### HIE functions used to connect with other practitioners

<table>
<thead>
<tr>
<th>HIE functionalities</th>
<th>Australia</th>
<th>Canada</th>
<th>England</th>
<th>France</th>
<th>Germany</th>
<th>Singapore</th>
<th>Spain</th>
<th>US</th>
</tr>
</thead>
<tbody>
<tr>
<td>I communicate electronically with clinicians in other organizations (e.g. secure email)</td>
<td>15%</td>
<td>35%</td>
<td>12%</td>
<td>28%</td>
<td>32%</td>
<td>47%</td>
<td>29%</td>
<td>35%</td>
</tr>
<tr>
<td>I am electronically notified of my patients' interactions with other health organizations (e.g. hospital admissions)</td>
<td>24%</td>
<td>6%</td>
<td>14%</td>
<td>11%</td>
<td>41%</td>
<td>9%</td>
<td>11%</td>
<td>13%</td>
</tr>
<tr>
<td>I electronically send or receive referrals to/from health professionals in other organizations (e.g. specialist appointments)</td>
<td>20%</td>
<td>12%</td>
<td>16%</td>
<td>16%</td>
<td>52%</td>
<td>19%</td>
<td>17%</td>
<td>21%</td>
</tr>
<tr>
<td>I have electronic access to clinical data about a patient who has been seen by a different health organization (e.g. hospital, laboratory)</td>
<td>24%</td>
<td>28%</td>
<td>27%</td>
<td>34%</td>
<td>51%</td>
<td>31%</td>
<td>23%</td>
<td>36%</td>
</tr>
<tr>
<td>I electronically send prescriptions to pharmacies (e-Prescribing)</td>
<td>6%</td>
<td>3%</td>
<td>10%</td>
<td>7%</td>
<td>11%</td>
<td>14%</td>
<td>5%</td>
<td>17%</td>
</tr>
<tr>
<td>I receive clinical results electronically that populate my patients' electronic medical record</td>
<td>84%</td>
<td>40%</td>
<td>35%</td>
<td>37%</td>
<td>90%</td>
<td>38%</td>
<td>61%</td>
<td>43%</td>
</tr>
<tr>
<td>I electronically send order requests (e.g. lab, radiology or diagnostic tests) to other health organizations</td>
<td>28%</td>
<td>17%</td>
<td>14%</td>
<td>22%</td>
<td>46%</td>
<td>43%</td>
<td>12%</td>
<td>21%</td>
</tr>
<tr>
<td>Health information exchange--average</td>
<td>29%</td>
<td>20%</td>
<td>18%</td>
<td>22%</td>
<td>46%</td>
<td>29%</td>
<td>23%</td>
<td>27%</td>
</tr>
</tbody>
</table>

Note: 1=Primary care; 2=Secondary care. Purple shows the lowest score, Green shows the highest score across all eight countries for each of the functions.
Findings

Stage 3: Insight Driven Healthcare

How patient data is currently entered in the system:
Accenture physician survey

- US
- Spain
- Singapore
- Germany
- France
- England
- Canada
- Australia
- Average Survey Total

Legend:
- Coded
- Structured
- Unstructured
In Summary

1. Although BIG DATA is classically defined by the “3-Vees:” Volume, Velocity and Variety
   • The value is not in size, but what you do with the data
   • Enough data and the right data is more important

2. Continue along the analytics journey, both in:
   • Maturity
   • Moving from descriptive to predictive

3. Identify, invest in and train the talent needed to understand and interpret the data, processes to collect and communicate results and evolve governance