Big Data and Healthcare

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Challenges Facing U.S. Healthcare

- Balancing Infinite Demand versus Finite Resources
- From Volume-Based FFS Care to Value-Based Care
- From Reactive Interventions in Disease Episodes to Proactive Continuity of Care Services
- Improving Outcomes at Lower Cost and Realizing the Wellness Premium
- Technological Innovation and New Value Propositions in Healthcare
The Path to Precision Medicine: From Superstitions to Symptoms to Signatures
Precision Medicine

(Epi)Genomics

Causal Relationships Between Molecular Network Disruptions and Disease

Patient-Specific Signatures of Disease or Predisposition to Disease

Big Data

- terabytes per individual
- zettabyte – yottabyte datasets for populations

Big Data
Still Two Largely Separate Worlds

- research initiatives in precision medicine
  - $5-10 billion (estimated)

- routine healthcare delivery: a complex ecosystem
  - $3 trillion (18% GDP)
Precision Medicine and Data-Intensive Computational Medicine: Evolving Inter-Dependencies

- Molecular classification of disease and elucidation of disease mechanisms
- Large scale data aggregation, curation, and analysis
- RWE analytics and learning healthcare systems
“I don’t think of Humana so much as an insurance company as an IT company who is helping us with the data that we need in order to deal with our population health tools.”

Dr. Roy Beveridge, M.D.
CMO, Humana
Cited in Fierce Healthcare 9 May 2017
- The majority of events that influence wellness/disease risk occur largely outside of formal interactions with the healthcare system.

- Daily decisions by individuals have greater effects on their health than decisions controlled by the healthcare system.
Mapping Genotype-Phenotype Relationships and Disease Risk:
Systematic Integration of Diverse Data for Population Health Analytics
Continuity of Care Record: From Womb to Tomb
Social Spaces Become Quantifiable

- who knows why people do what they do?
  - the fact is that they do!
- these actions can now be traced and measured with unprecedented precision
- with sufficient data, the numbers reveal increasingly predictable behavior and individual risk patterns
- new ethical and legal issues
  - consent, privacy, surveillance, security
Invasion of the Body Trackers: Expanding the “Care Space” in Healthcare

- Healthcare Beyond The Clinic
- Remote Health Status Monitoring
- Smartphones, Wearables, Devices and Digital Services
- M4: Making Medicine More Mobile
Remote Health Status Monitoring
Gray Technologies and Aging in Place: Independent But Monitored Living for Aging Populations

- Rx adherence
- Cognitive stimulation
- In home support and reduced readmissions
- Reduced office visits
Digital Personal Assistants

Kuri (Mayfield Robotics)
Population Health Research and Precision Medicine: Blurring the Boundaries Between Research and Clinical Care

- every encounter (clinical and non-clinical) is a data point
- every individual is a data node
- every individual is a research asset
- every individual is their own control
Mobile Apps, Wearables, Sensors and Continuous Health Status Monitoring

- who sets the standards?
- who integrates and interprets the data?
- who pays?
- who consents?
- who owns the data?
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The Big Data Challenge

V6: volume, variety, velocity, veracity, virtualization, value
D3: distributed, dynamic, decision support
I3: infrastructure, investment, intelligent systems
Now Comes the Hard Part!

Driving Precision Medicine and Data-Driven Healthcare Into Routine Clinical Practice

The Problem with Real World Data is the Real World
HELL IS THE PLACE WHERE NOTHING CONNECTS — T.S. ELIOT
Silos Subvert Solutions: Protecting Turf and Sustaining the Status Quo

Welcome to biomedical research and patient medical records.
The Worst Supply Chain in Society: The Health Information Supply Chain

- fragmented, disconnected data
- incompatible data formats as barrier to data integration
- incomplete and inaccurate data
- slow transition from paper to electronic systems
- inadequate information on behavioral and environmental influences on health
- legislative barriers to data transfer based on well intentioned privacy protections
- organizational, economic and cultural barriers to open data sharing
Intrinsic Tensions in Open Data Policies and Data Sharing in Biomedicine

- privacy and security protections
- need for ‘large N’ datasets versus private/proprietary data and analytical algorithms
- poor interoperabilities: the EMR vendor trap and deliberate information blocking
- incentives and rewards versus cultural resistance/economic burden to sharing in the research community
- data ownership
The Pending Era of Cognitive Computing and Decision-Support Systems: Overcoming the “Bandwidth” Limits of Human Individuals

- limits to individual expertise
- limits to our multi-dimensionality
- limits to our sensory systems
- limits to our experiences and perceptions
- limits to our objective decision-making
The Slow Brain and the Fast Machine

Cognitive Computing, Deep Learning and Machine Intelligence

The Future Workforce and the Future of Work
Machine Learning and Image Analysis in Clinical Medicine

- large scale training sets and classification parameters
- standardized, reproducible and scalable
- 260 million images/day for $1000 GPU
Automated Context: Data Finding Data
“Intelligence at Ingestion”

Feature Extraction and Classification
Context Analysis
Persistent Context

- Relevance Detection
- Learning Systems

- Situational Awareness
- Rapid, Robust Decisions
The Evolving Healthcare Information Ecosystem

**Technology**
- Sensors, robotics
- Computing and automation
- Life sciences research and clinical medicine

**Connectivity, Continuity and Consumerism**
- Big Data
- Social media
- Patient engagement
- Life style metrics

**Population Health**
- Precision Medicine
- Data Science
- AI

**Services Integration (Systems)**

**Analytics for Improved Decisions and Clinical Outcomes (Value)**

**The Expanded Care Space (Individuals)**
Deep Learning, Machine Learning and Artificial Intelligence in Data Analytics and Decision Support

“I Can’t Let You Do That Dave”

Automated Decision Support Tools and “Gated Autonomy” in the Management of Complex Systems
Living in a World Where the Data Analytics and Interpretation Algorithms Are Obscure to the End User

- ceding decision authority to computerized support systems
- culturally alien to professionals in their claimed expertise domain but they accept in all other aspects of their lives
- who will have the responsibility for validation and oversight of critical assumptions used in decision tree analytics for big data?
  - regulatory agencies and professional societies?
  - humans?
  - machines?
CHANGE is good you go first
DNR

Denial  Negativity  Resistance
The Rise of Data-Intensive Medicine and Digital Healthcare

The Intellectual Foundation for a New Era in Clinical Medicine and Public Health

From Reactive Responses to Illness Episodes to Proactive Continuity in Care to Optimize Wellness (Risk Reduction)

Profound Organizational Economic and Cultural Disruption in Healthcare Delivery and Professional Competencies

New Business Models and New Participants Previously Uninvolved in Healthcare