The Strategic Landscape for Healthcare: Balancing Technological Innovation and the Cost of Care

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The U.S. Healthcare System

- estimated $3.2 trillion expenditures
- estimated 17.5 percent of US economy
- one in seven American workers is employed in the healthcare sector
Disease Burden:
Confronting the Largest Economic Disruptions and Threats to Sustainable Healthcare

cancer
neurodegeneration
cardio-vascular/metabolic disease
mental illness
Challenges Facing U.S. Healthcare

Balancing Infinite Demand versus Finite Resources

From Volume-Based (Do More-Bill More) FFS to Value-Based Care

From Reactive, Episodic Interventions in Advanced Disease to Proactive Identification of Disease Risk and Earlier Detection

Improving Clinical Outcomes at Lower Cost and Optimizing Wellness
Challenges Facing U.S. Healthcare

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Value
Precision Medicine
Digital Medicine
Precision Medicine

Mapping Disease Risk and Disease Processes at the Molecular Level
Medical Progress:
From Superstitions to Symptoms to Signatures
Precision Medicine:
Mapping the Disruption of Molecular Signaling Networks in Disease

(Epi)Genomics

Proteomics

Molecular Signaling (Information) Networks

Perturbed Networks and Disease

ID of Causal Relationships Between Network Perturbations and Disease

Patient-Specific Signals and Signatures of Disease or Predisposition to Disease
Population

One-Size-Fits-All

Treatment A (effective in 20% of target population; 80% is waste)

Molecular Profiling and Disease Subtypes

Treatment A
Treatment B
Treatment C
Treatment D
INTESTINAL MICROBIOTA IN HEALTH AND DISEASE
A map of diversity in the human microbiome

- nutrition
- autoimmunity
- obesity
- neuroimmunology
- Rx response
Most Events That Affect Our Health Occur Outside Of The Healthcare System And Are Not Monitored.

Building Comprehensive Healthcare Information Systems To Better Track Disease Risk(s) For Earlier Intervention.
Most Events That Affect Our Health Occur Outside of the Healthcare System And Are Not Monitored

Need for Continuity of Care Record: From Womb to Tomb
Changing The Touch Points in Healthcare Delivery: Healthcare Beyond the Clinic

- Invasion of the Body Trackers
- Remote Health Status Monitoring: Wearables, Sensors and Devices
- M4: Making Medicine More Mobile
m.Health

Real Time Remote Health Monitoring and Chronic Disease Management

Lifestyle and Fitness

Information for Proactive Health Awareness (Wellness)
“Medical Selfies”: The Proliferation of Mobile Devices in Healthcare
Robotics, Telemedicine and Connecting to Expert Opinion
Implantable Devices and Wireless Monitoring (and Modulation)

next-generation miniaturized power sources

security and hacker protections
Smart Materials for Improved Therapeutic Adherence
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)
- Amazon Alexa
- Microsoft Cortana
- WeChat
- Baidu
- Your.MD
- VIV

Kuri (Mayfield Robotics)
“Do you solemnly swear to have no involvement in your own care?”
Patients Are No Longer Patient for Solutions

Patient Communities and Disease Advocacy Groups

Increased Patient Engagement in Care Decisions and Disease Management
Consumerism in Healthcare and Retail: Any Real Difference?

**Actionable Information**
- anytime
- anywhere

**Choice**
- pricing and performance (transparency)
- best resource (outcome)
- best value (outcomes/cost)
Precision Medicine and Digital Medicine: Evolving Inter-Dependencies

**Individual Data**
- Matching individual profiles to best treatment interventions

**Population Databanks**
- Integration and analysis of large scale, diverse data
Monitoring Health Risks

- 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

- major implications for healthcare delivery, disease management and optimizing wellness

- new ethical and legal issues regarding data acquisition and use
  - consent, privacy, surveillance, security
HELL IS THE PLACE WHERE NOTHING CONNECTS — T.S. ELIOT
WELCOME TO THE CURRENT STATE OF HEALTH CARE INFORMATION SYSTEMS

HELL IS THE PLACE WHERE NOTHING CONNECTS — T.S. ELIOT
Security of Health Data in the Cloud
Advanced Computing, Robotics and Machine Intelligence

Implications for Professional Competencies in Healthcare
New Visualization Tools, and Human-Machine Interactions
Big Data and the V6 Challenge: Volume, Variety, Velocity, Veracity, Visualization, Value

Data Deluge

Cognitive Bandwidth Limits

Automated Analytics and Decision Support

Facile Formats for Actionable Decisions
Cognitive Computing and Decision-Support Systems: Overcoming the “Bandwidth” Limits of Humans

- limits to individual expertise
- limits to our sensory systems
- limits to our experiences and perceptions
limits to objective decision making in the face of escalating, multi-dimensional complexity
Deep Learning, Machine Learning and Image Recognition for Biomedical Diagnosis and Disease Staging

- digital pathology
- radiology
- ophthalmology
- cardiovascular architecture
Machine Intelligence, Biometrics and Improved Clinical Decisions
Computational Analysis of Facial Expressions, Voice, Social Interaction Patterns in Diagnostic Profiling of Psychiatric Disorders

- high variation in assessment of same patients by different psychiatrists
- major need for objective measurements of nuanced behavior
  - gaze
  - speech prosody (rhythm, tone, volume)
  - stimulus response reactions and interaction speed
- AI and learning from large video banks
  - bipolar disorder, schizophrenia, depression
  - suicidal ideation
  - PTSD
- signal alerts to care teams when intervention is indicated
Data Finding Data: “Intelligence at Ingestion” and Improved Decisions

Feature Extraction and Classification → Context Analysis → Relevance, Ranking, Probabilistic Algorithms → Rapid, Informed Decisions
Deep Learning, Smart Machines, Artificial Intelligence and Decision Support Systems

“I Can’t Let You Do That Dave”

Automated Decision Support Tools and “Gated Autonomy” in the Management of Complex Systems
Ceding Decision Authority to Computerized Support Systems

- culturally alien to professionals in their claimed expertise domain but they accommodate in all other aspects of their lives
- who will have responsibility for validation and oversight of critical assumptions used in decision tree analytics?
  - regulatory agencies and professional societies?
  - humans?
  - machines?
CHANGE

is good

you go first
DNR

Denial

Negativity

Resistance
The Future of Healthcare: Precision Medicine and Digital Medicine

- Molecular profiling
- Computing and automation
- Sensors, robotics
- Molecular classification of disease

- New technology platforms
- The expanded care space
- Remote monitoring of health status
- Social media
- Patient engagement
- Life style metrics

Remote monitoring of health status
The Future of Healthcare: Precision Medicine and Digital Medicine

- BIG DATA
  - EMRs
  - Population
  - Databanks
  - Precision Medicine
  - Digital Medicine
  - AI

- molecular profiling
- computing and automation
- sensors, robotics
- patient engagement
- social media
- life style metrics

new analytics for improved decisions and clinical outcomes at lower cost (value)
Precision Medicine and Digital Medicine

The Intellectual and Economic Drivers of a New Era in Clinical Medicine and Public Health

Profound Economic, Operational and Cultural Implications for the Organization of Future Healthcare Delivery Channels and Professional Competencies
Slides available @ http://casi.asu.edu/