

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

**Dr. George Poste**

Chief Scientist, Complex Adaptive Systems Initiative  
and Regents Professor of Health Innovation

Arizona State University

[george.poste@asu.edu](mailto:george.poste@asu.edu)

[www.casi.asu.edu](http://www.casi.asu.edu)

**Keynote Address**

**IEEE Phoenix Section, Annual Banquet**

**Phoenix, AZ**

**11 February 2017**

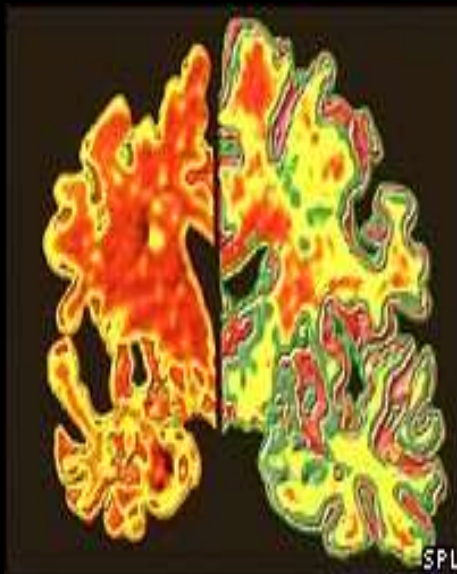
# **The U.S. Healthcare System**

- **estimated \$3.2 trillion expenditures**
- **estimated 17.5 percent of US economy**
- **one in seven American workers is employed in the healthcare sector**

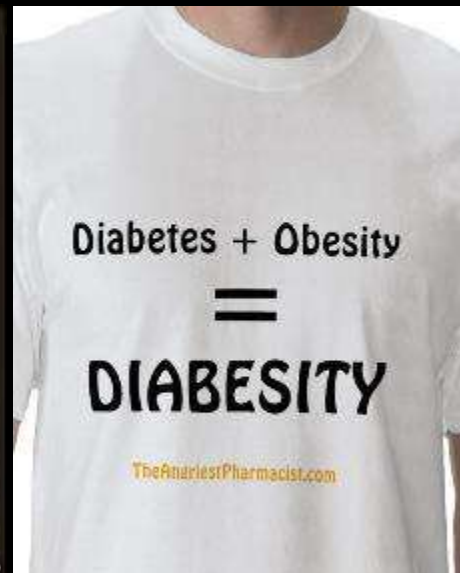
# **Disease Burden: Confronting the Largest Economic Disruptions and Threats to Sustainable Healthcare**



**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

**Balancing Infinite Demand versus Finite Resources**

**value**

**From Volume-Based (Fee-For-Service) to Value-Based Care**

**Precision Medicine**

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

**Digital Medicine**

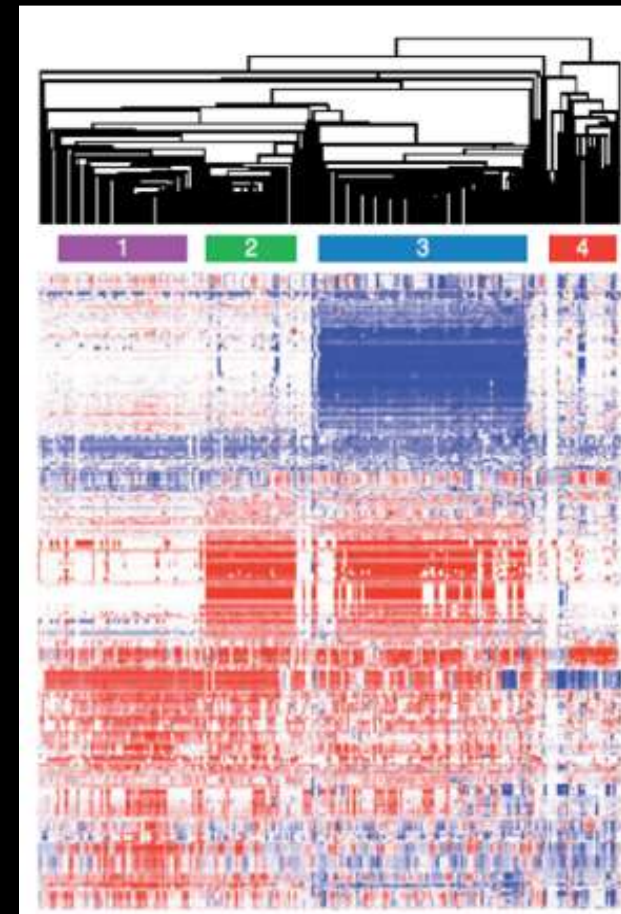
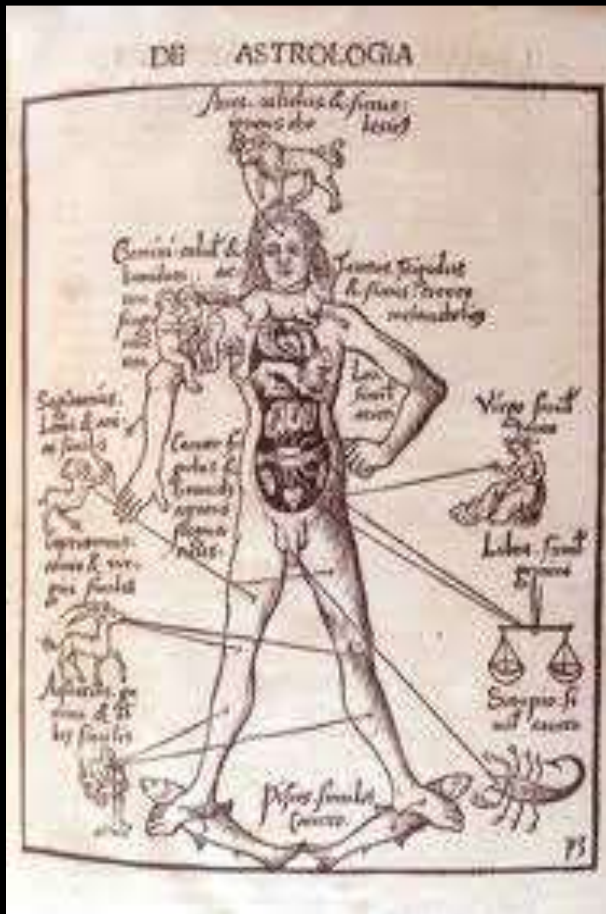
**Improving Clinical Outcomes at Lower Cost- and Optimizing Wellness**

## **Precision Medicine**

**Mapping Disease Risk and  
Disease Processes at the Molecular Level**

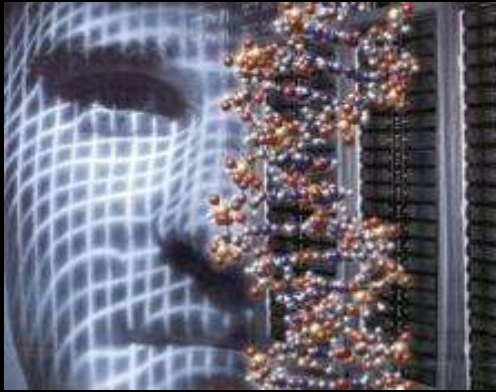


# Medical Progress: From Superstitions to Symptoms to Signatures

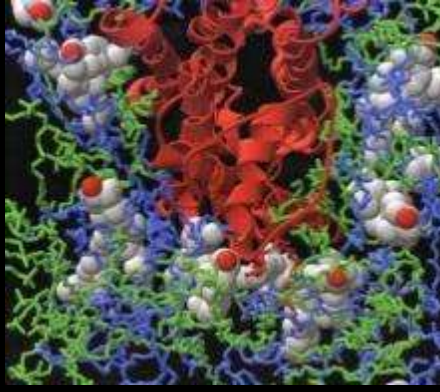


# Precision Medicine: Mapping the Disruption of Molecular Signaling Networks in Disease

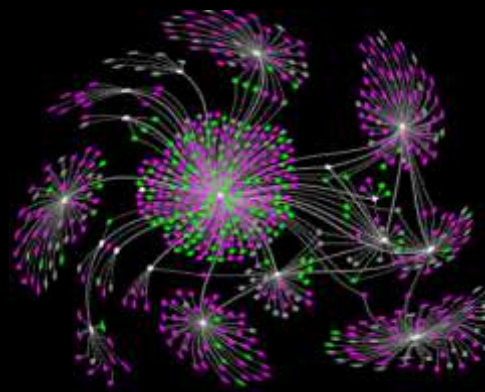
**(Epi)Genomics**



**Proteomics**



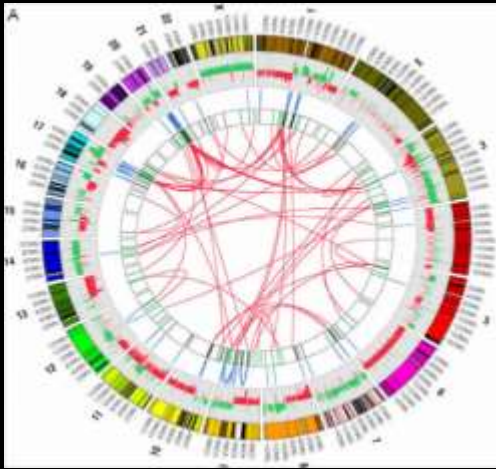
**Molecular Signaling  
(Information) Networks**



**Perturbed Networks  
and Disease**



**ID of Causal Relationships Between  
Network Perturbations and Disease**

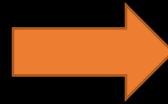
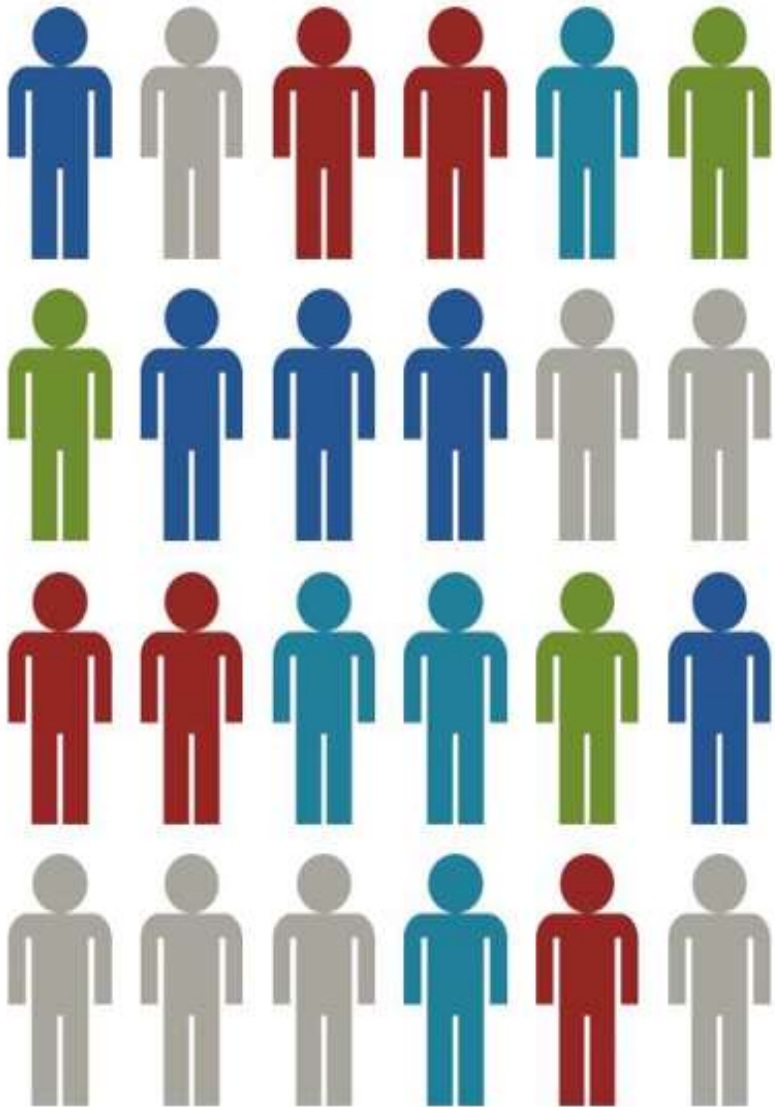


**Patient-Specific Signals and Signatures of  
Disease or Predisposition to Disease**

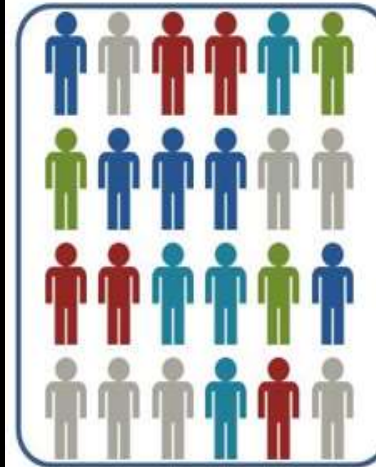




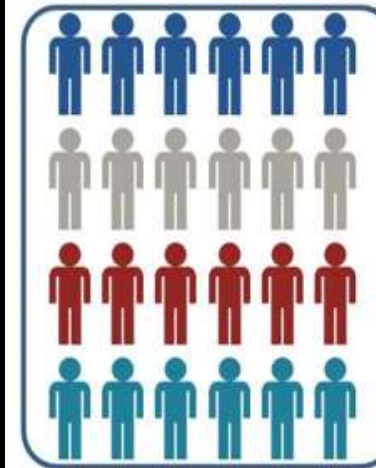
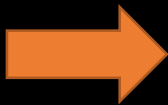
## Population



## One-Size-Fits-All



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



Treatment A

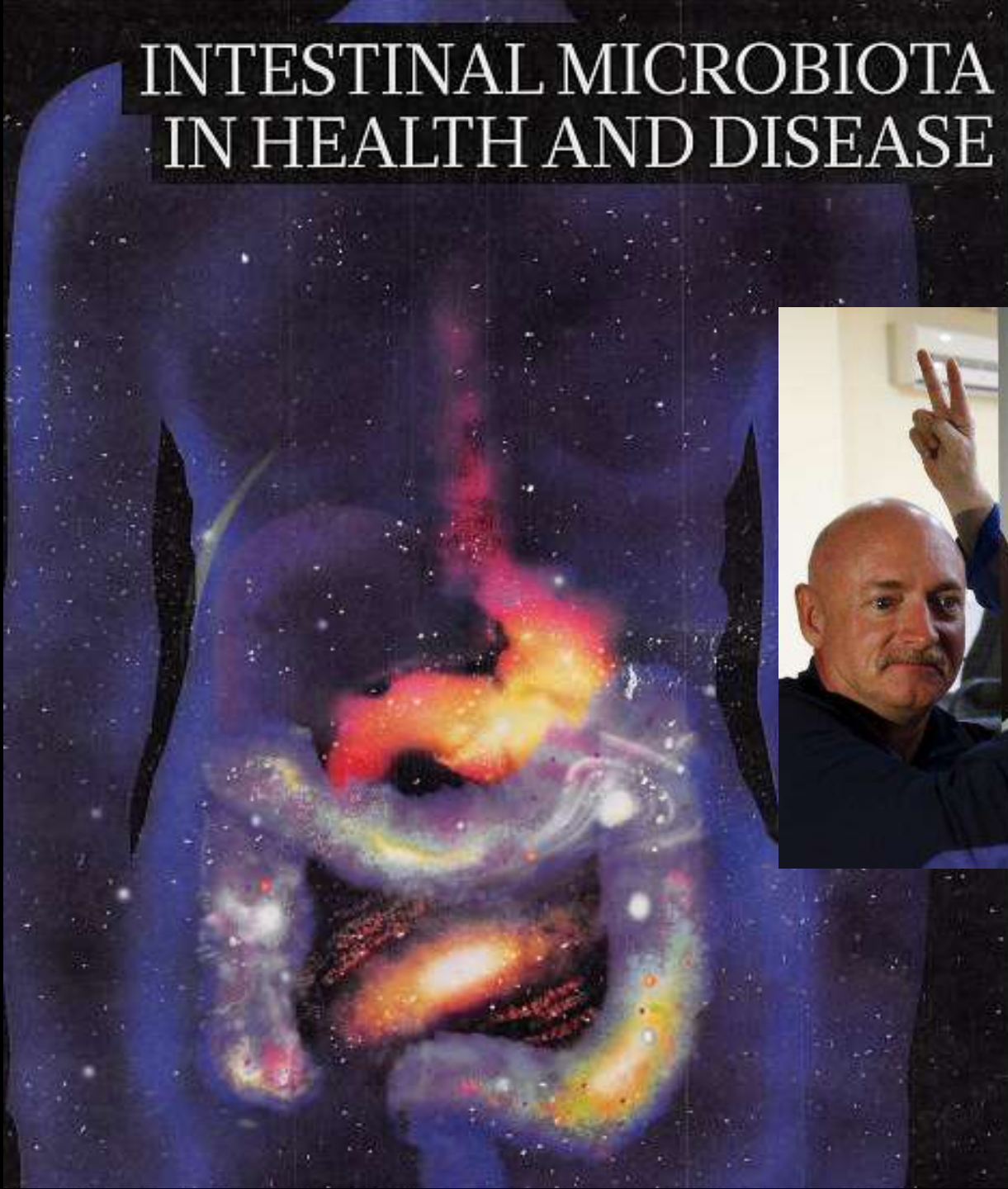
Treatment B

Treatment C

Treatment D

**Molecular Profiling  
and Disease Subtypes**

# INTESTINAL MICROBIOTA IN HEALTH AND DISEASE







# Precision Medicine

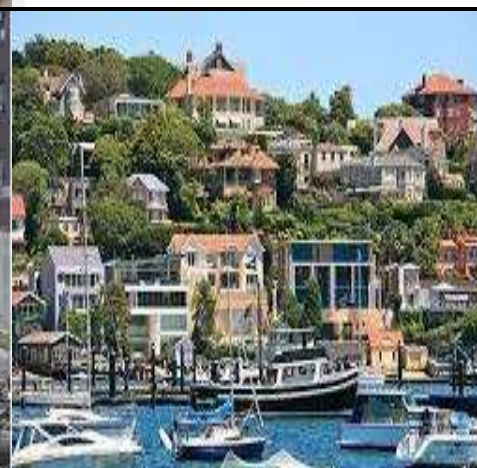
**Most Events That Affect Our Health Occur Outside Of The Healthcare System And Are Not Monitored**

**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



**Behavior**

**Environment**

# **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)**

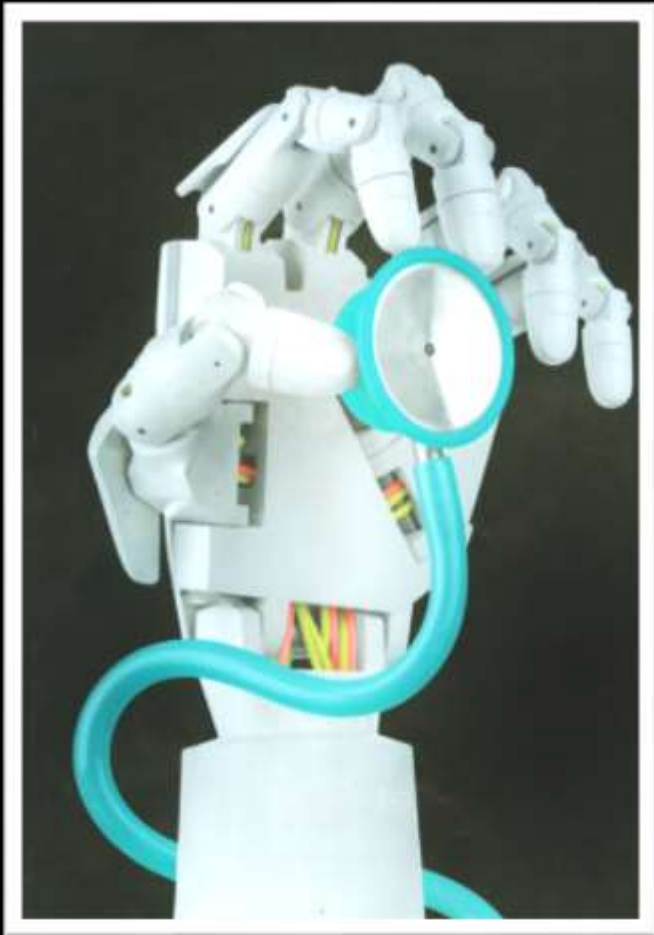


# **“Medical Selfies”: The Proliferation of Mobile Devices in Healthcare**

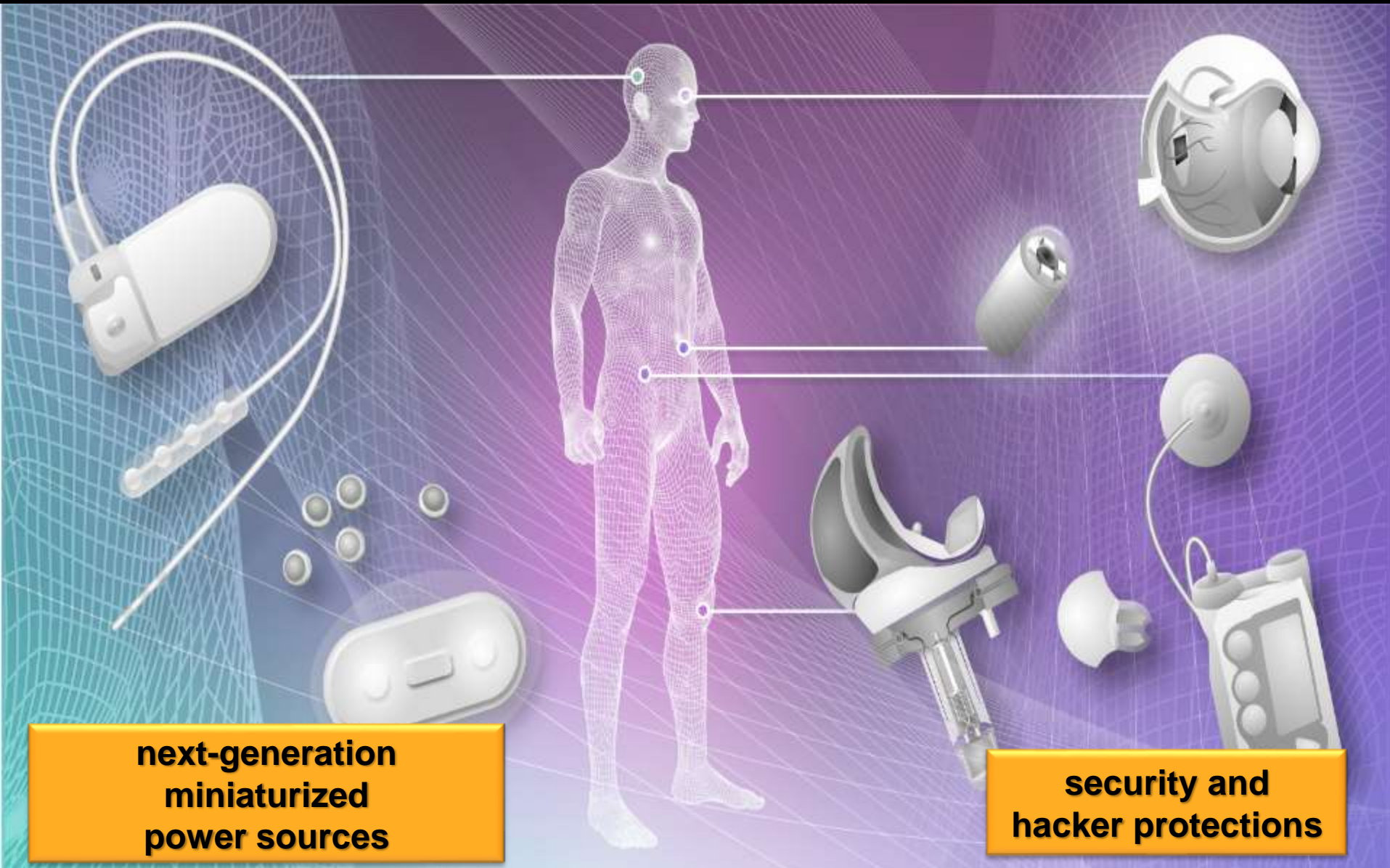




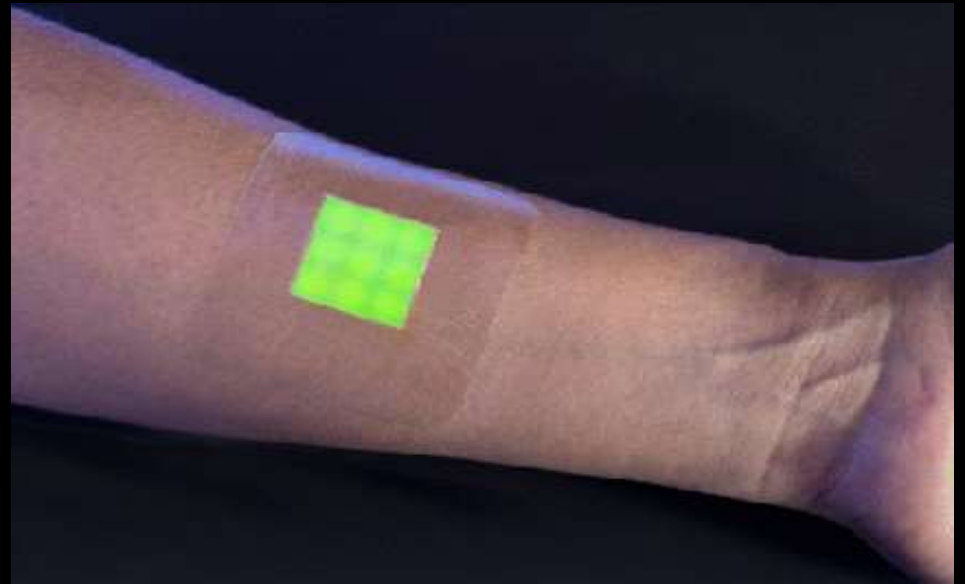
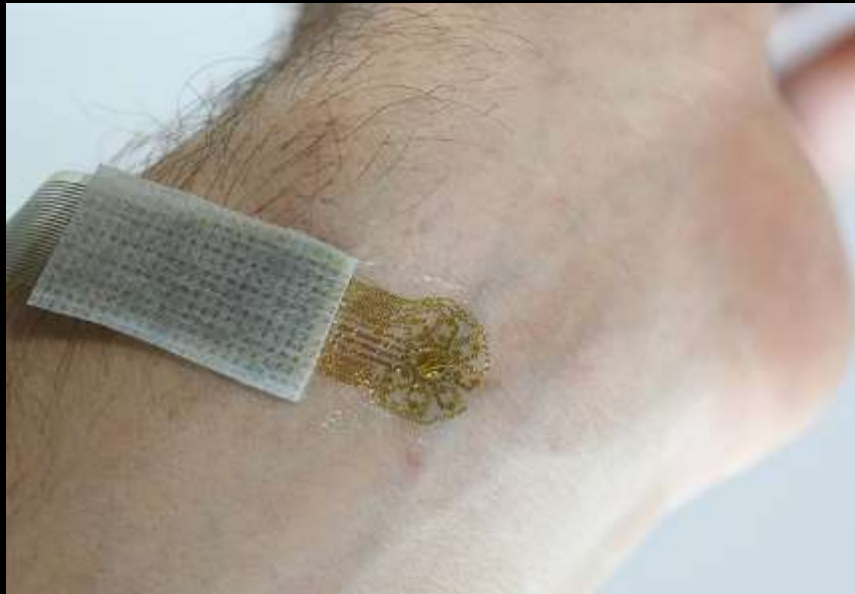
# Robotics, Telemedicine and Connecting to Expert Opinion



# Implantable Devices and Wireless Monitoring (and Modulation)



# 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)



“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)

Ux

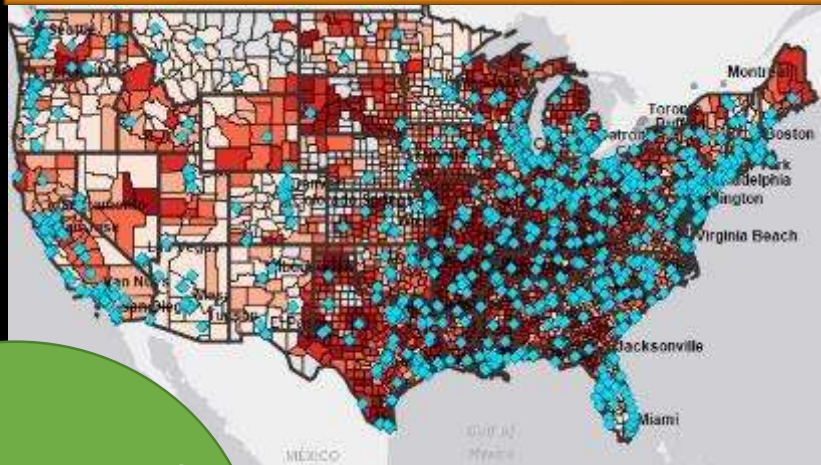


# Precision Medicine and Digital Medicine: Evolving Inter-Dependencies

## Individual Data



## Population Databanks



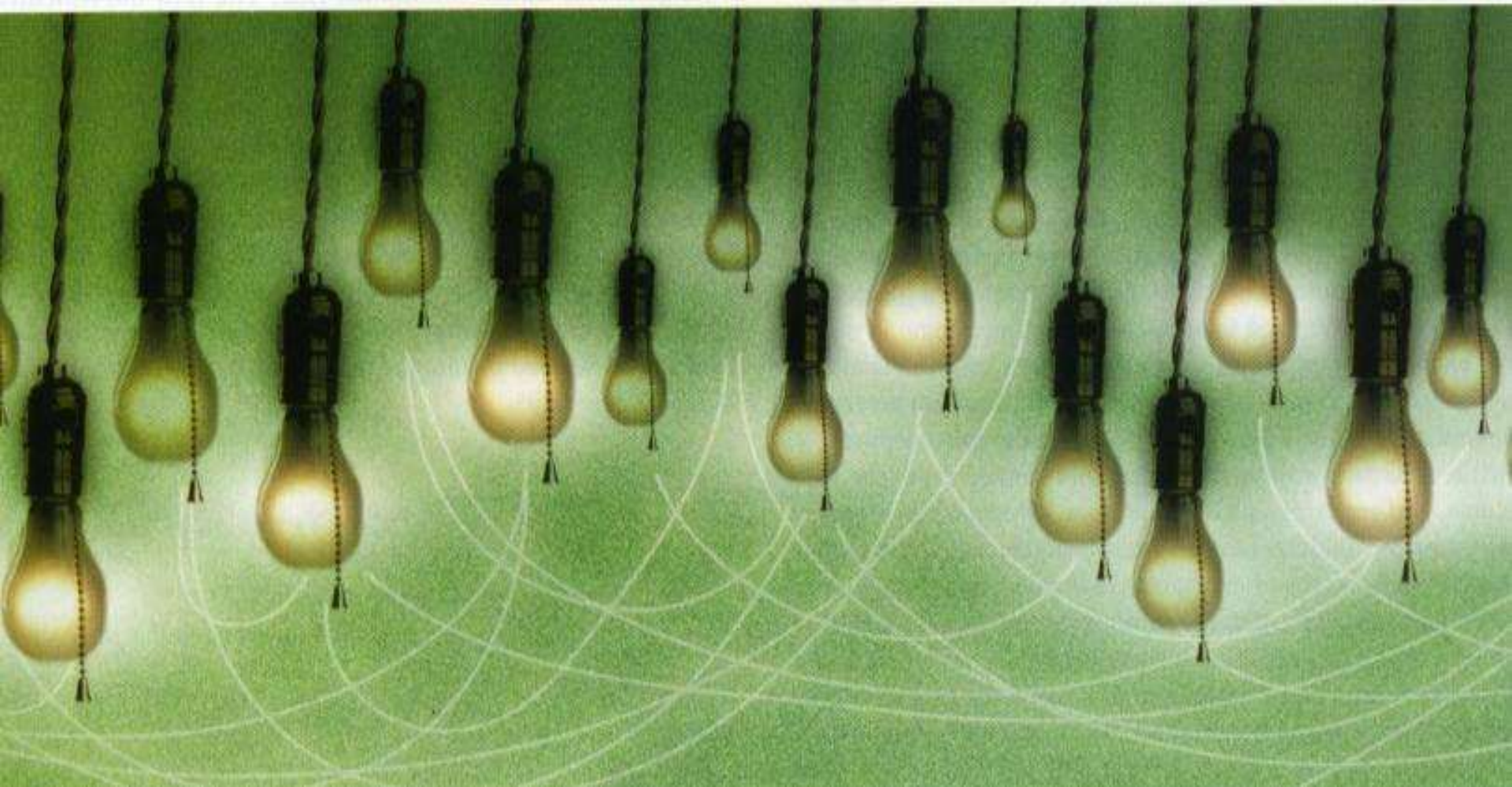
integration and  
analysis of large  
scale, diverse  
data

matching individual profiles to best  
treatment interventions


# 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





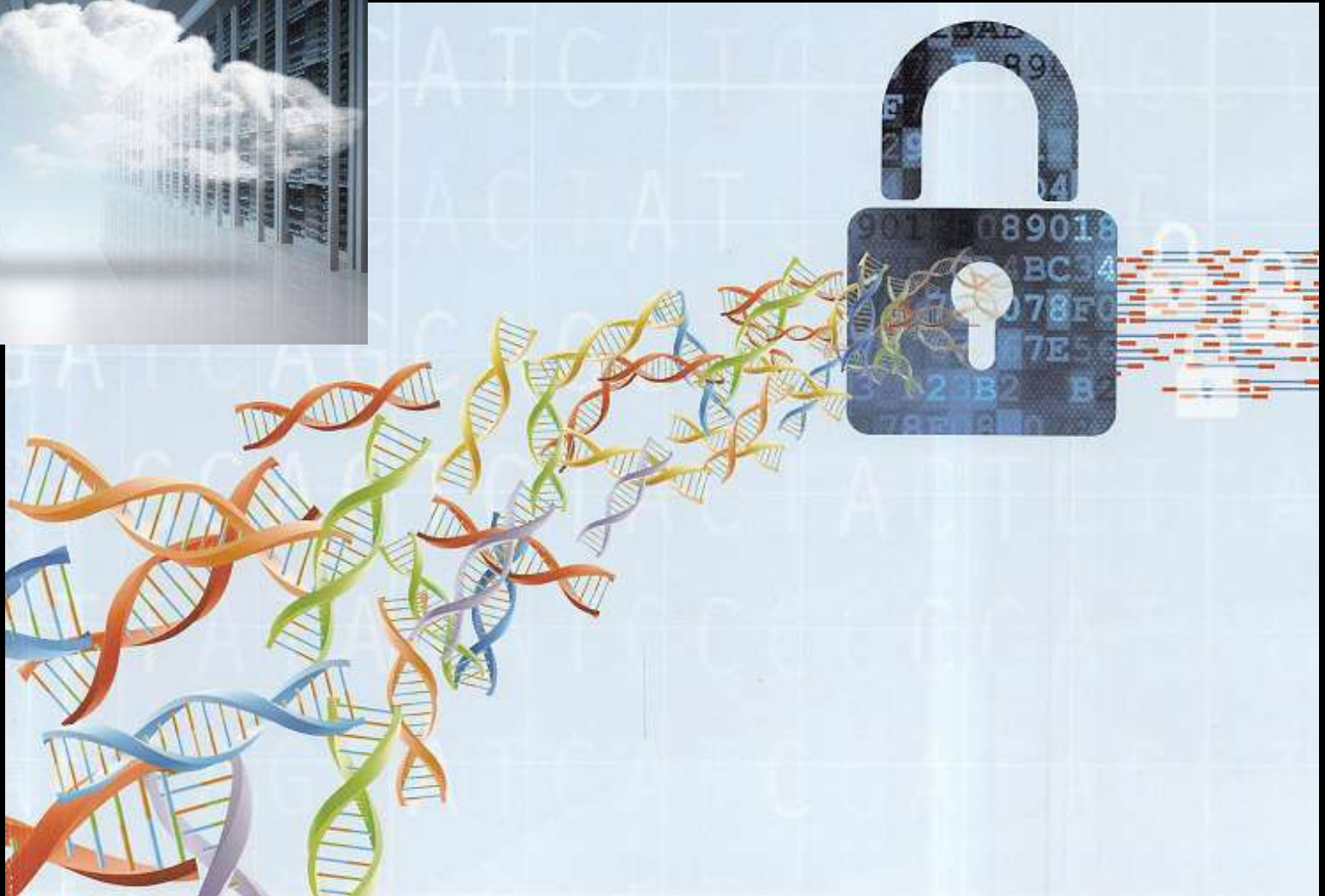


HELL IS THE PLACE WHERE NOTHING CONNECTS — T.S. ELIOT



**WELCOME TO  
THE CURRENT STATE OF  
HEALTH CARE INFORMATION SYSTEMS**

# 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

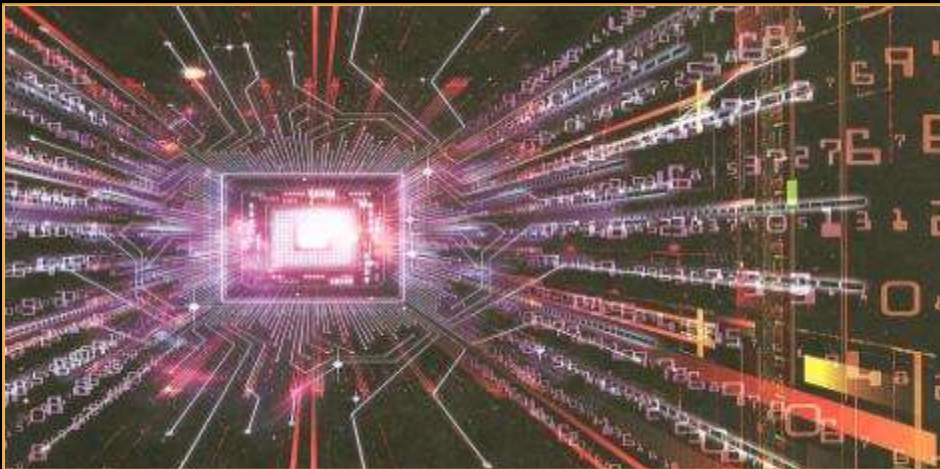
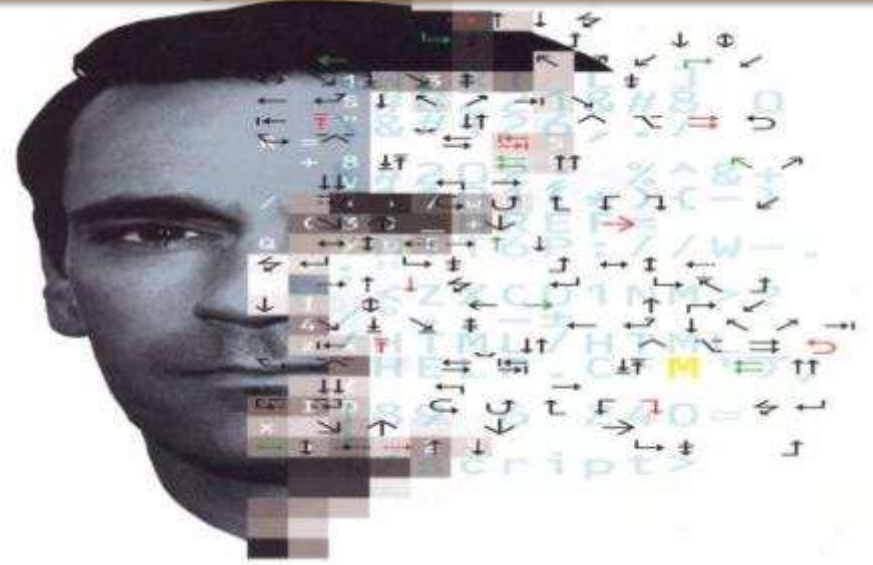


# Big Data and the V6 Challenge: Volume, Variety, Velocity, Veracity, Visualization, Value

**Data Deluge**



**Cognitive Bandwidth Limits**



**Automated Analytics and Decision Support**



**Facile Formats for Actionable Decisions**

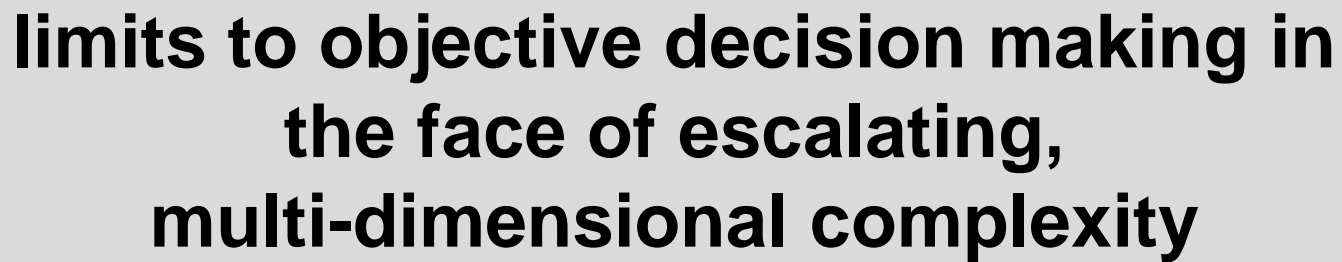


# Cognitive Computing and Decision-Support Systems: Overcoming the “Bandwidth” Limits of Humans

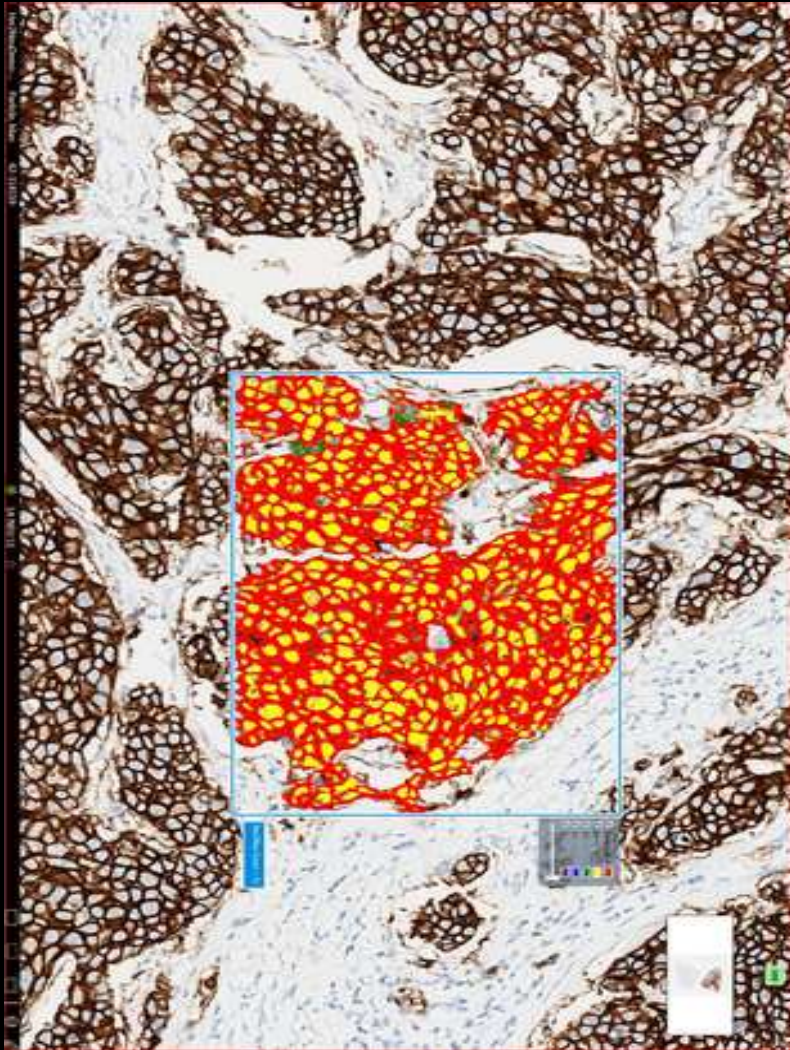


- limits to individual expertise
- limits to our sensory systems
- limits to our experiences and perceptions





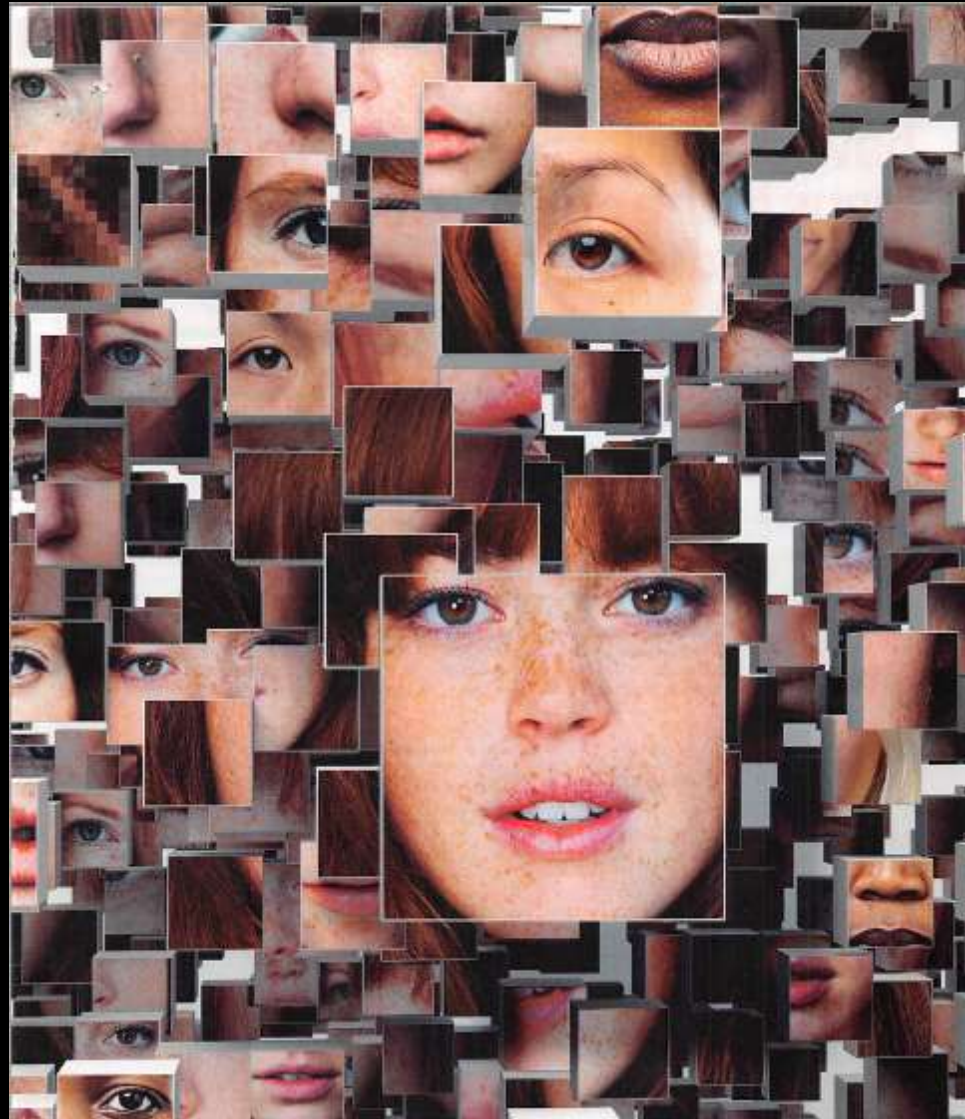
# Deep Learning, Machine Learning and Image Recognition for Biomedical Diagnosis and Disease Staging



- digital pathology
- radiology
- ophthalmology
- cardiovascular architecture



# Machine Intelligence, Biometrics and Improved Clinical Decisions

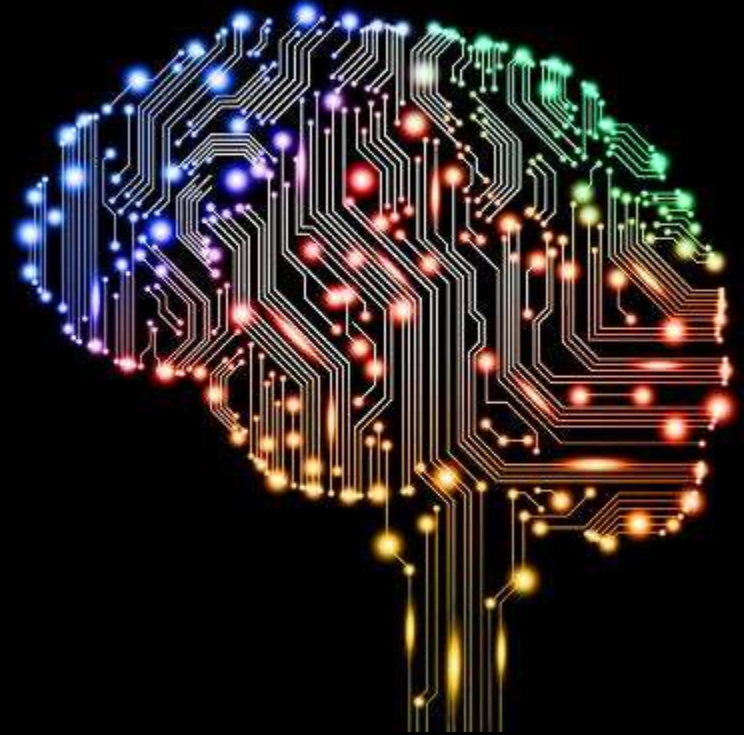
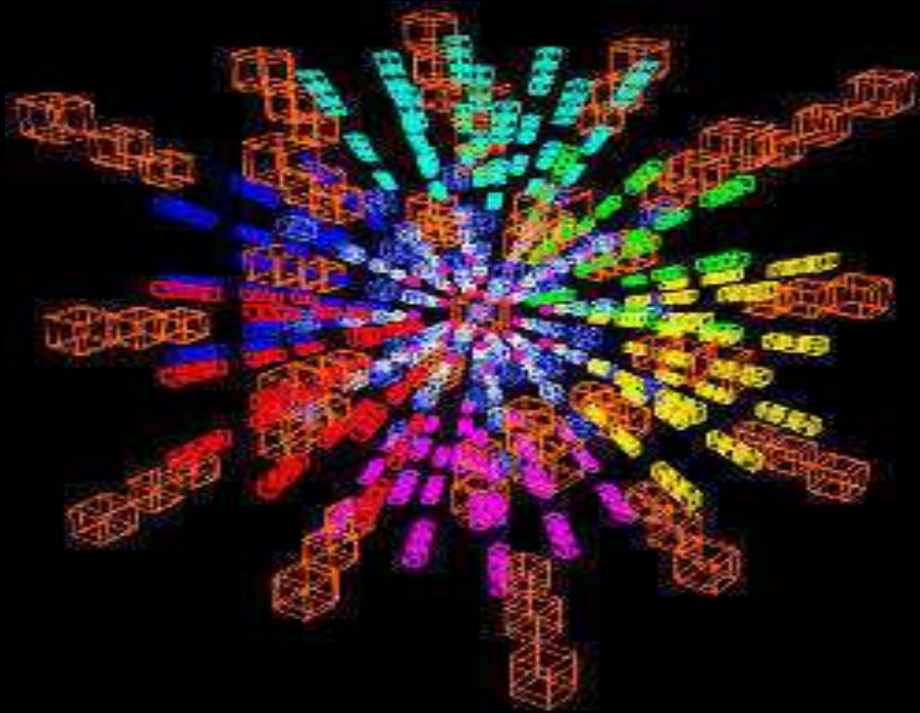




# **Computational Analysis of Facial Expressions, Voice, Social Interaction Patterns in Diagnostic Profiling of Psychiatric Disorders**

- **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



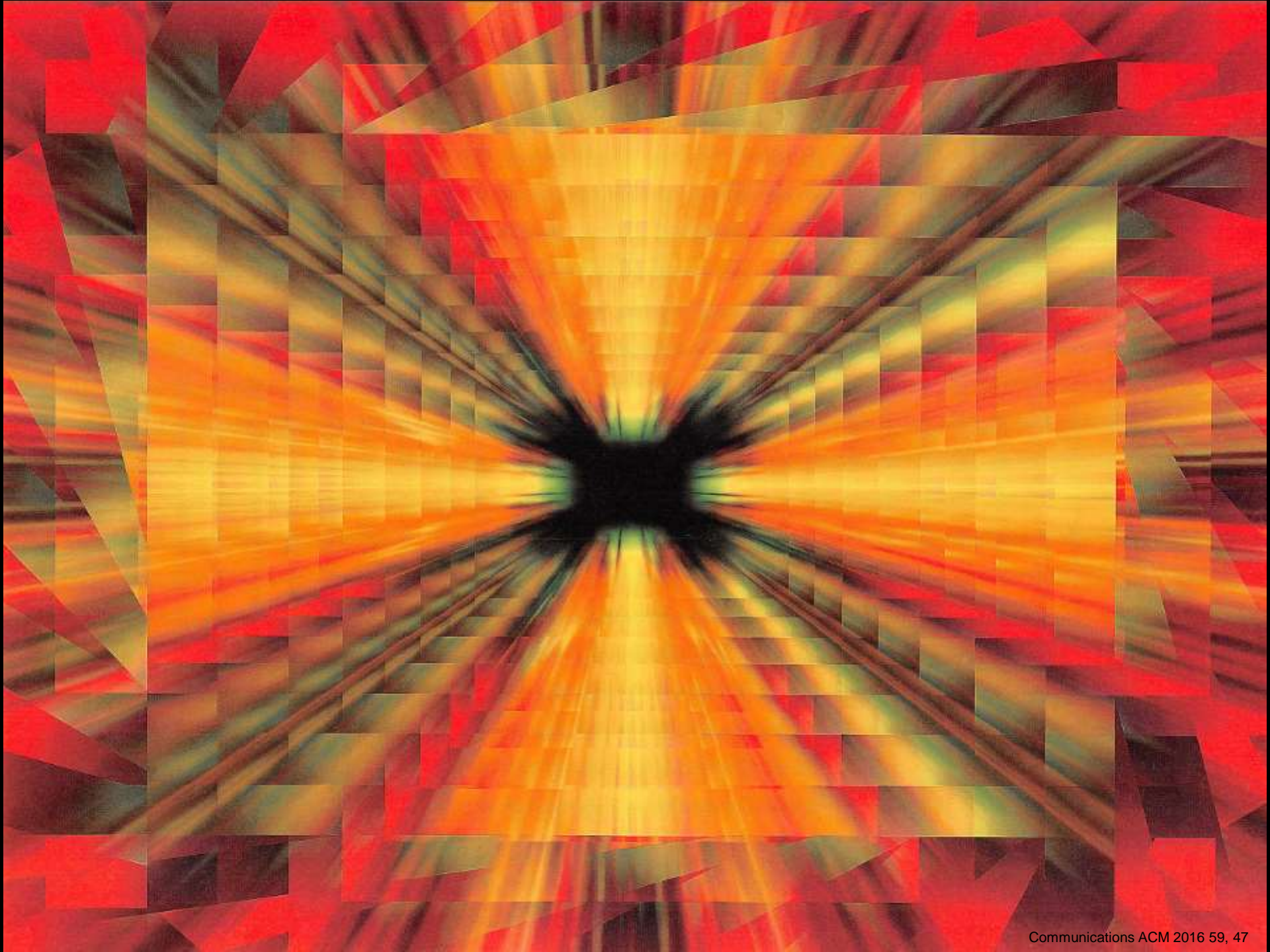
**“I Can’t Let You Do That Dave”**

**Automated Decision Support Tools and  
“Gated Autonomy” in the Management  
of Complex Systems**



# **Ceding Decision Authority to Computerized Support Systems**

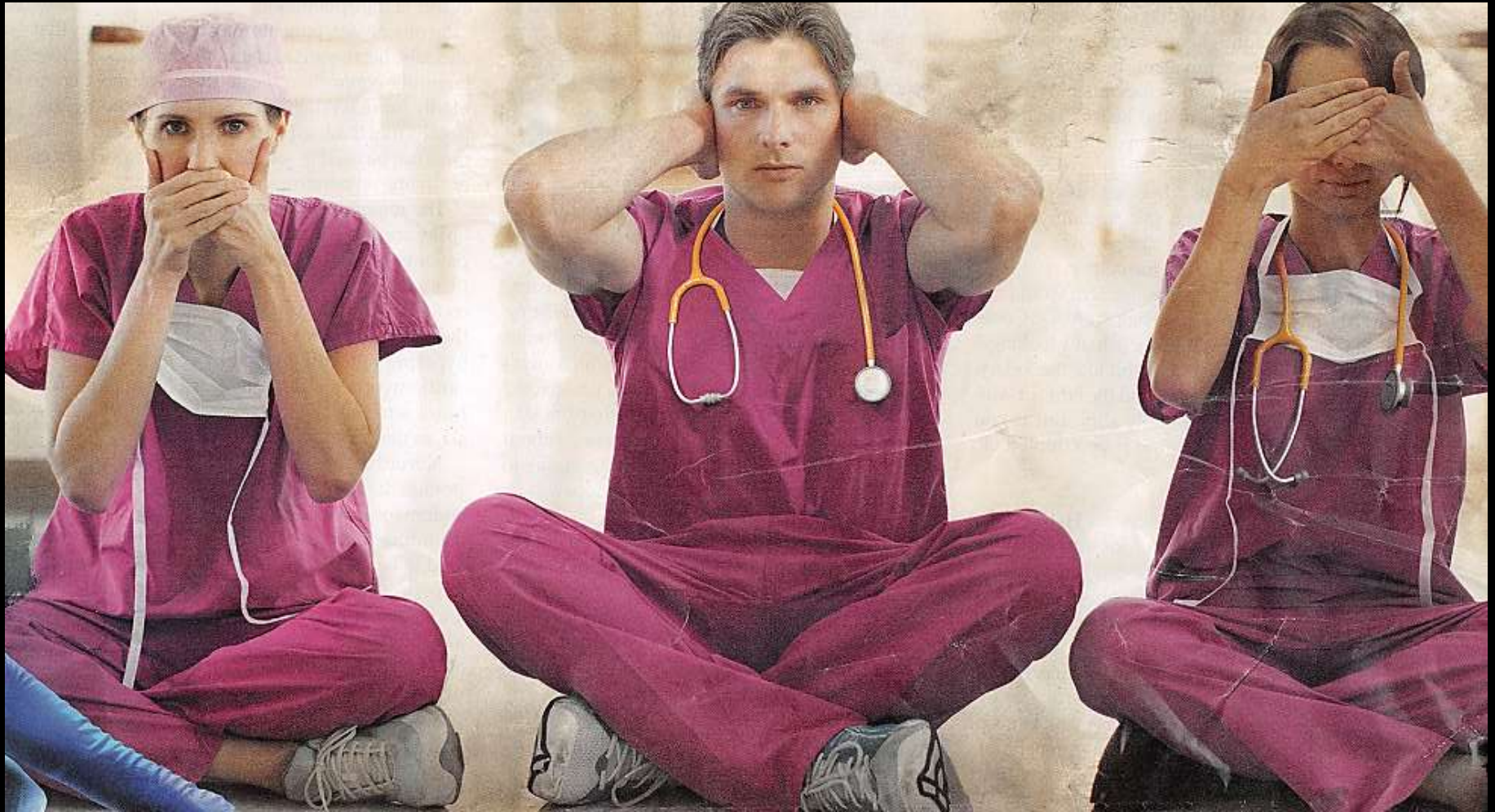
- **culturally alien to professionals in their claimed expertise domain but they accommodate in all other aspects of their lives**
- **who will have responsibility for validation and oversight of critical assumptions used in decision tree analytics?**
  - **regulatory agencies and professional societies?**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







# DNR



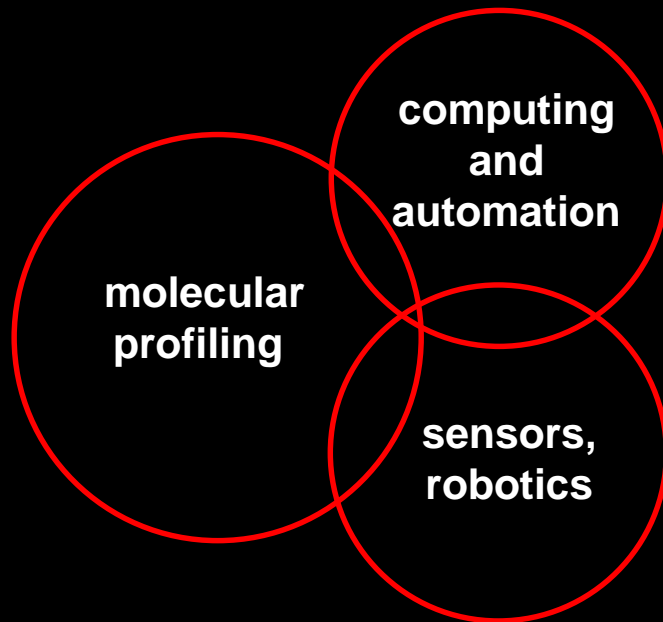
**Denial**

**Negativity**

**Resistance**

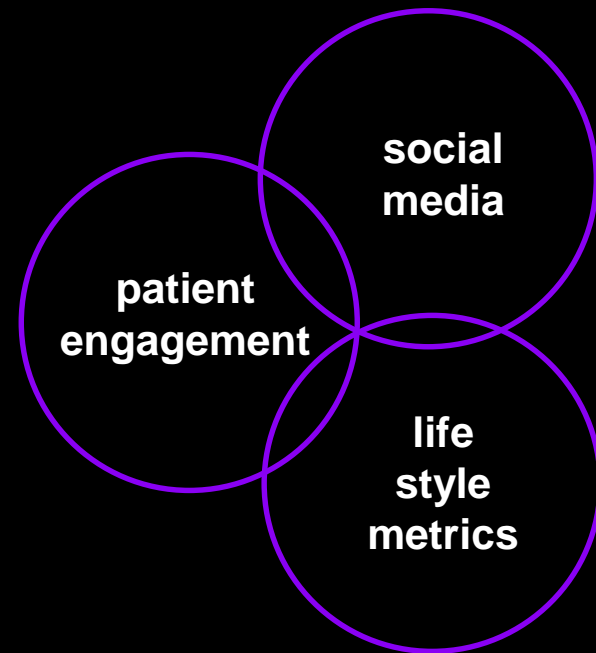
# **The Future of Healthcare: Precision Medicine and Digital Medicine**

**new technology  
platforms**



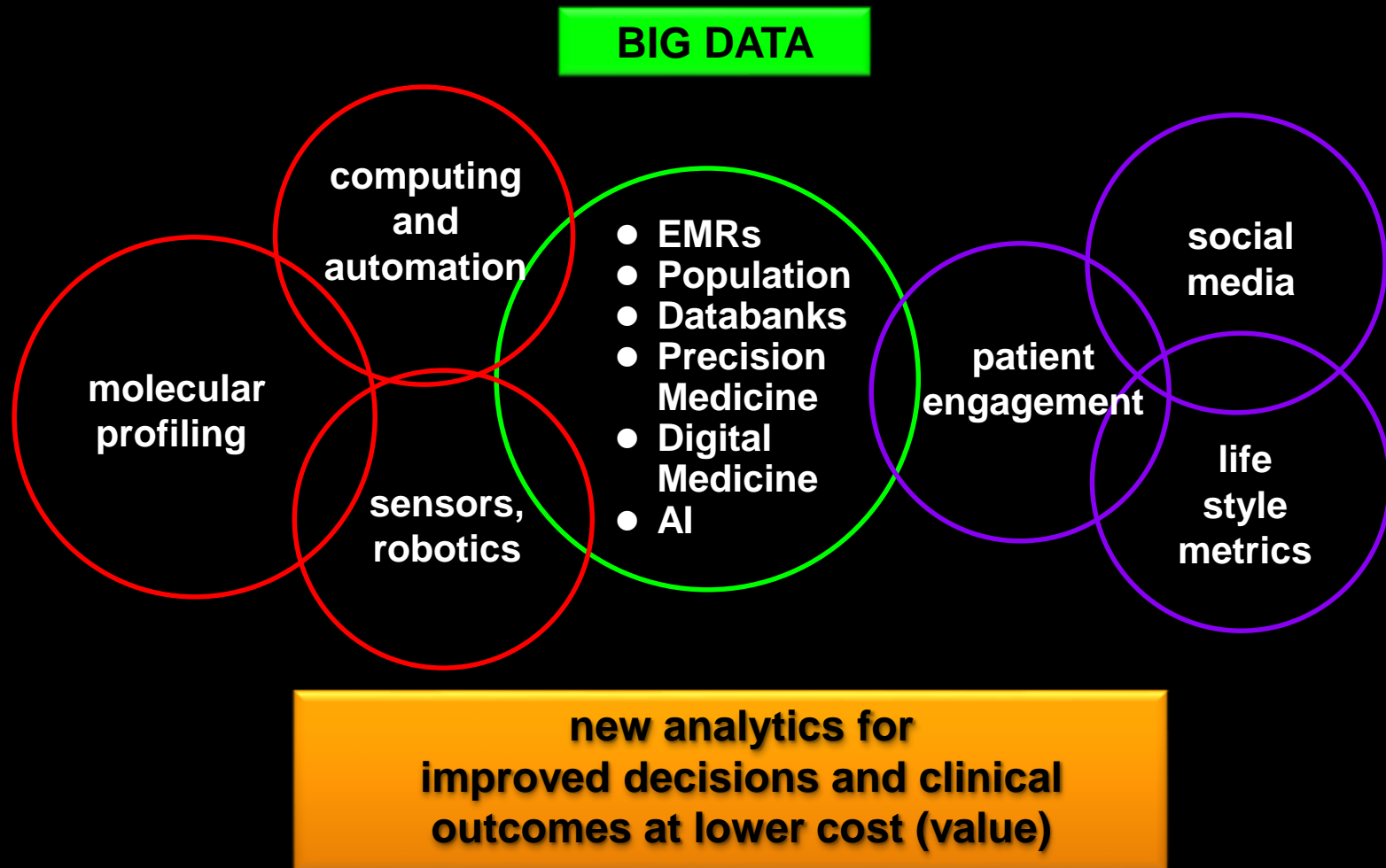
**molecular classification  
of disease**

**the expanded  
care space**



**remote monitoring of  
health status**

# The Future of Healthcare: Precision Medicine and Digital Medicine





# 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/>

