ASU Complex Adaptive Systems Initiative
Arizona State University

AAAS
Advancing Science, Serving Society

Big Data and Healthcare

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Panel Presentation: Big Data-Challenges and Social Impacts
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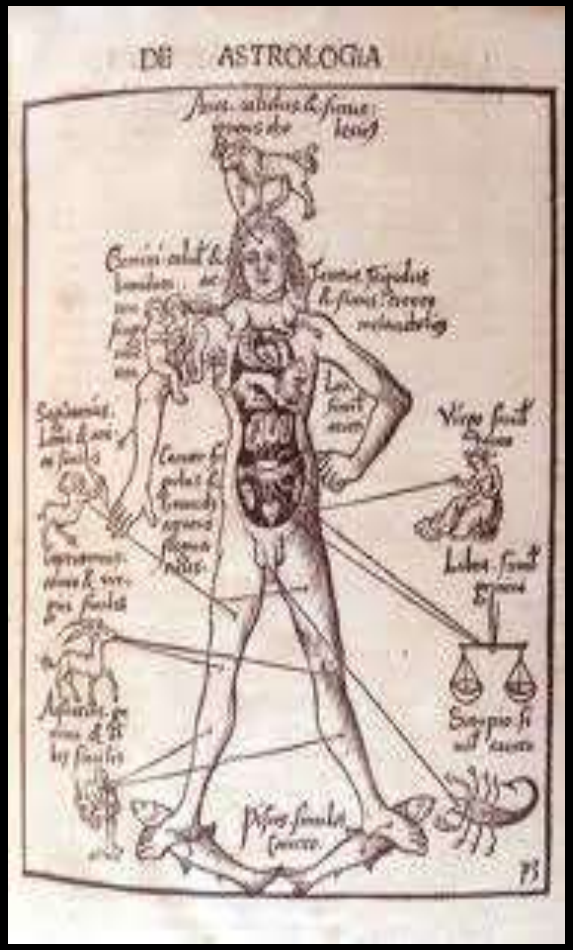
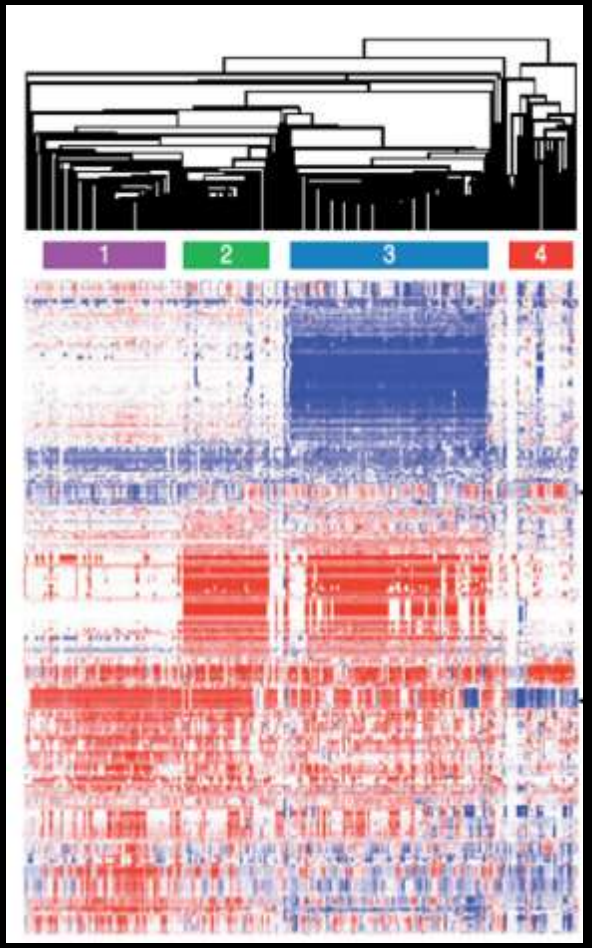
The Imperative to Achieve Sustainability in Healthcare: Societal (Economic) and Individual (Wellness)

- Balancing Infinite Demand Versus Finite Resources
- More Effective Management of Chronic Disease in Aging Populations
- Shift From a "Do More, Bill More" (FFS) Delivery of Care to Integrated Continuity of Care
- Managing Individual Risk to Improve Outcomes and Control Cost
- Technology, Innovation and New Value Propositions

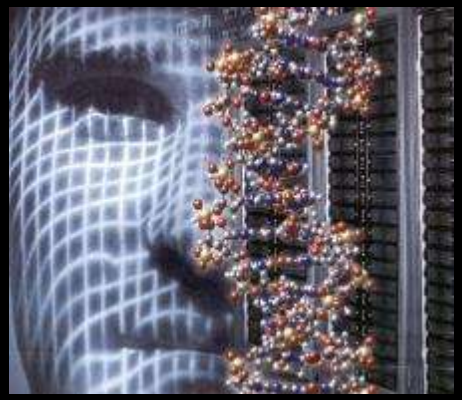
Medical Progress:
From Superstitions to Symptoms to Signatures



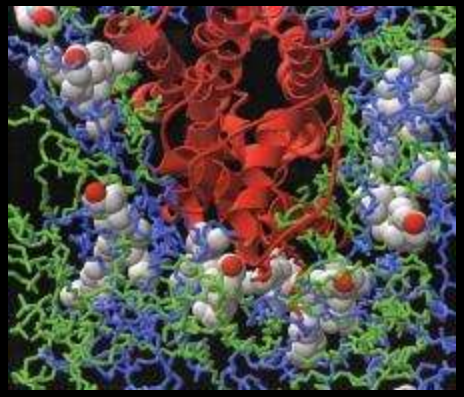


Precision Medicine: Understanding Molecular Signaling (Information) Pathways in Health and Disease

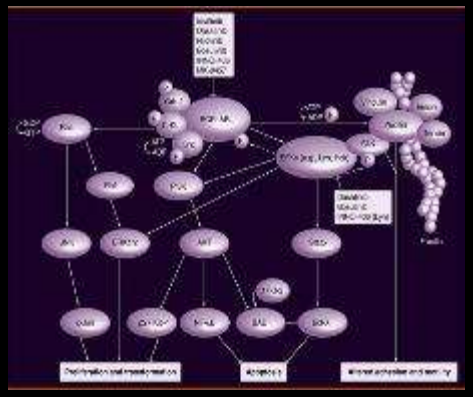
Genomics



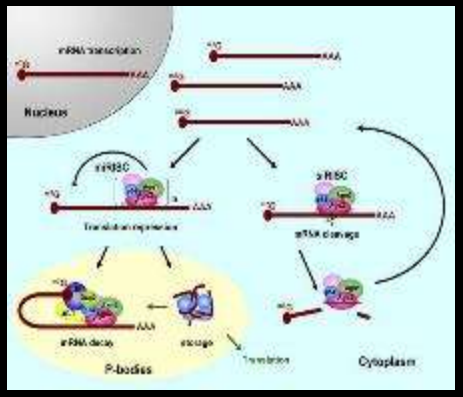
Proteomics

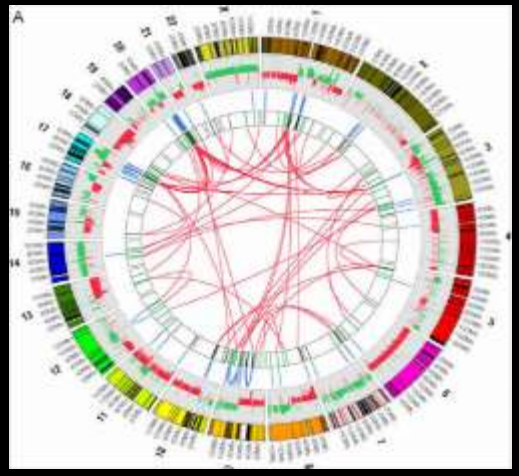


Molecular Pathways and Networks



Network Regulatory Mechanisms





ID of Causal Relationships Between Network Perturbations and Disease Subtypes

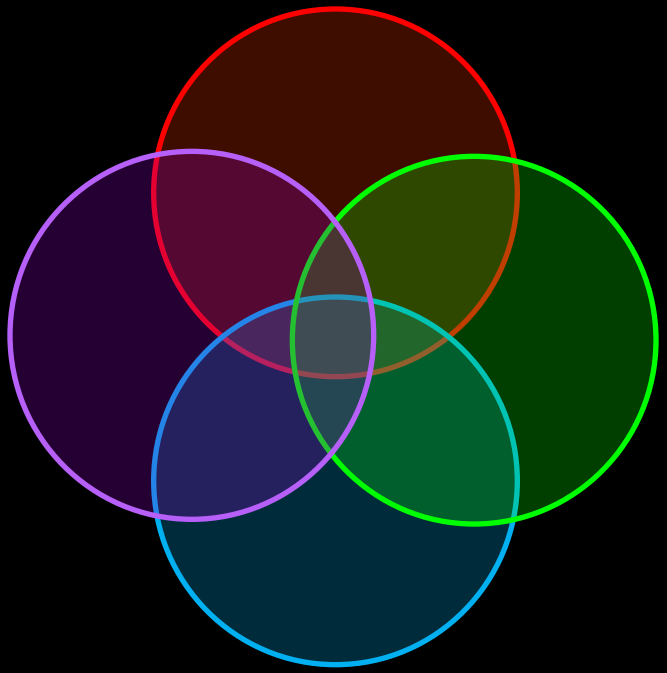
Patient-Specific Signals and Signatures of Disease or Predisposition to Disease and Targeted Rx

The Principal Forces Shaping Biomedical R&D and Healthcare Delivery

device-based medicine

- molecular diagnostics
- sensors

- remote health monitoring
- telemedicine



molecular (precision) medicine

- panOmics profiling
- integrated analytics of biological networks

information-based healthcare

- m.health/e.health
- data- and evidence-based decisions and Rx selection

outcomes-based healthcare and sustainable health

new value propositions, new business models and services

BIG DATA

The Changing ‘Touch Points’ in Healthcare Delivery

Sensors, Smart Devices, Social Media and
New Distributed Channels for Remote Health Monitoring

M4: Making Medicine More Mobile

AORTA (Always On Real Time Access), Healthcare and Wellness

- majority of events affecting an individual's health occur outside of healthcare facilities
- progressive migration to seamless blend of online and physical care and support services
- cultivate same expectations and engagement as other consumer-centric industries
- mass personalization
- innovation, insights, infrastructure and incentives

m.Health

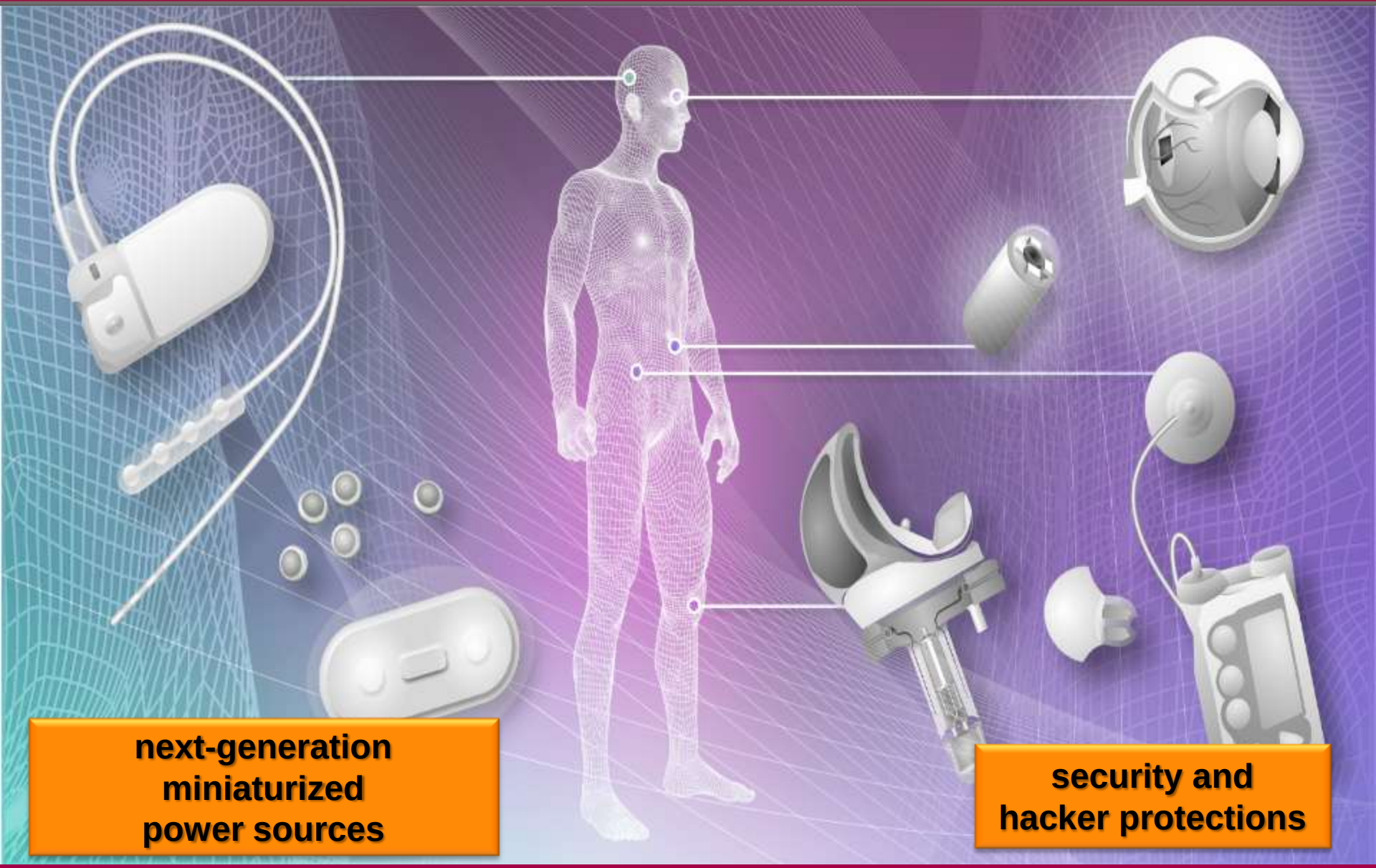
Real Time Remote Health Monitoring and Chronic Disease Management

Lifestyle and Fitness

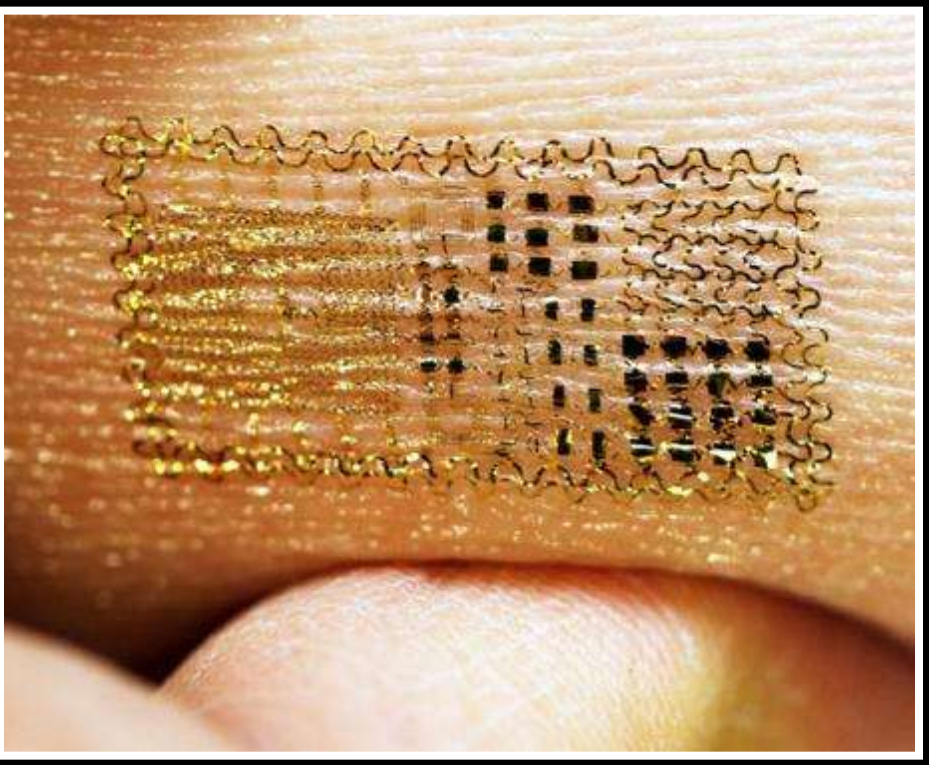
Information for Proactive Health Awareness (Wellness)

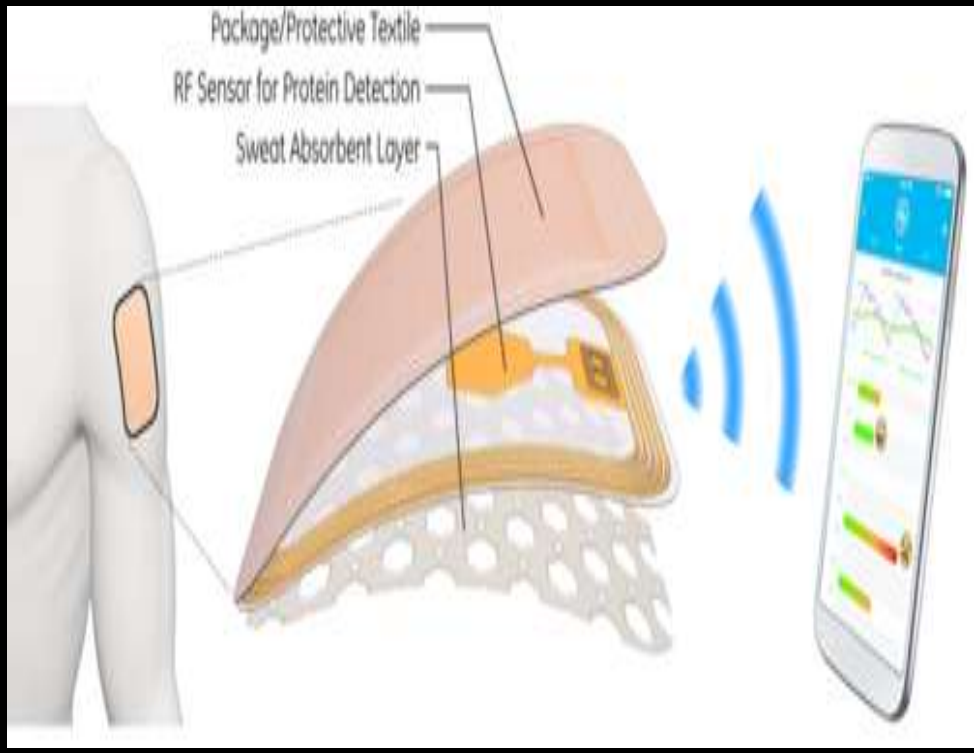
Telemedicine: Diagnostics, Robotics, and Remote Monitoring of Health

Implantable Devices and Wireless Monitoring (and Modulation)



“Lab-On-Me” and “Lab-Always-On” Dissolvable Electronics and Biodegradable Sensors





- dissolution of electronic circuits in physiological conditions
- construction from water-soluble, non-standard electronic materials with specific dissolution rates

Gray Technologies:
Independent But Monitored Living for Aging Populations

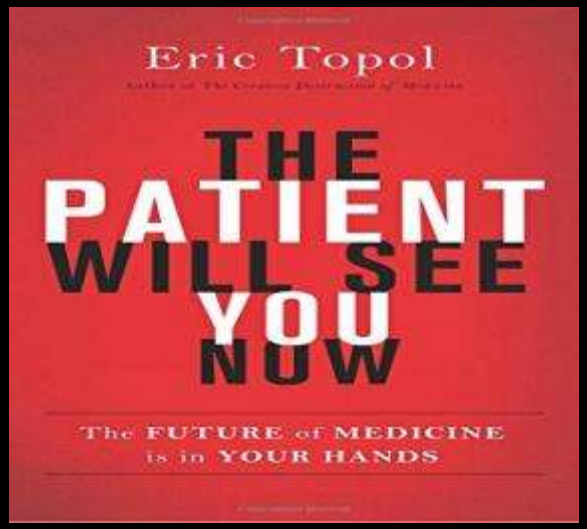
Rx compliance

cognitive stimulation

in home support and reduced readmissions

reduced office visits

Retail Healthcare:
New Services and Value-Based Shopping for Healthcare



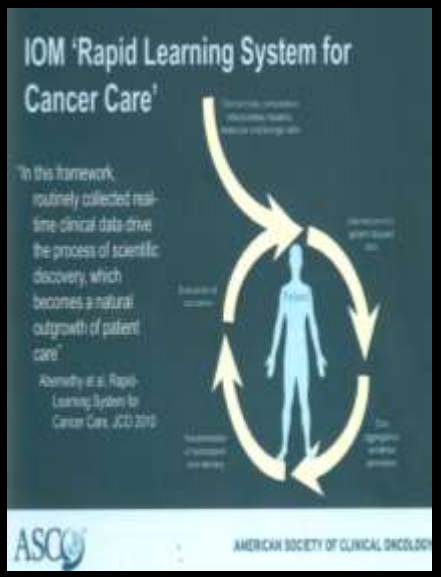
Social Spaces Become Quantifiable

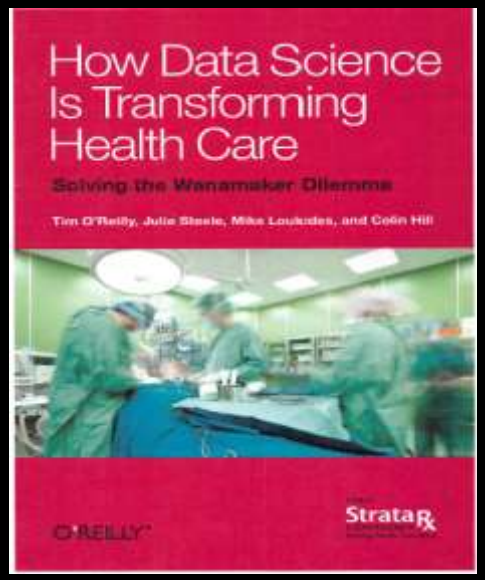
- who knows why people do what they do?
  - the fact is that they do!
- these actions can now be traced and measured with unprecedented precision
- with sufficient data, the numbers reveal increasingly predictable behavior individual risk patterns
- new business opportunities in multiple sectors including healthcare
- new ethical and legal issues
  - consent, privacy, surveillance, security

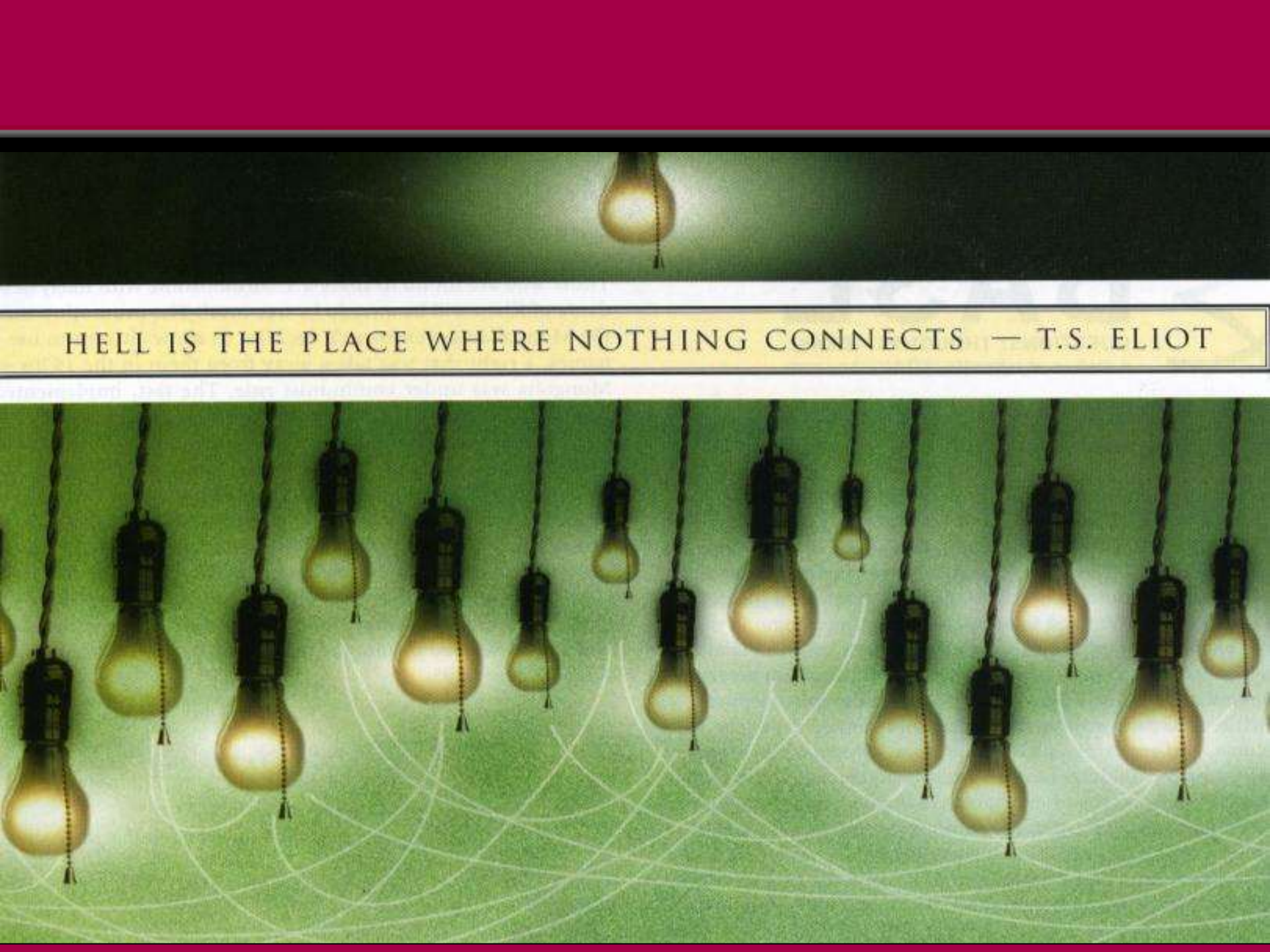
Health eHeart: Framingham Meets e.World

- recruitment of 1 million participants
- from profiling every two years (Framingham) to daily monitoring
- longitudinal observational monitoring with every individual acting as own control
- large sample size and avoidance of selection bias
- 1.5% cohort = entire Framingham study (15,000 participants)

Big Data and Healthcare: No-Shortage of Opinions

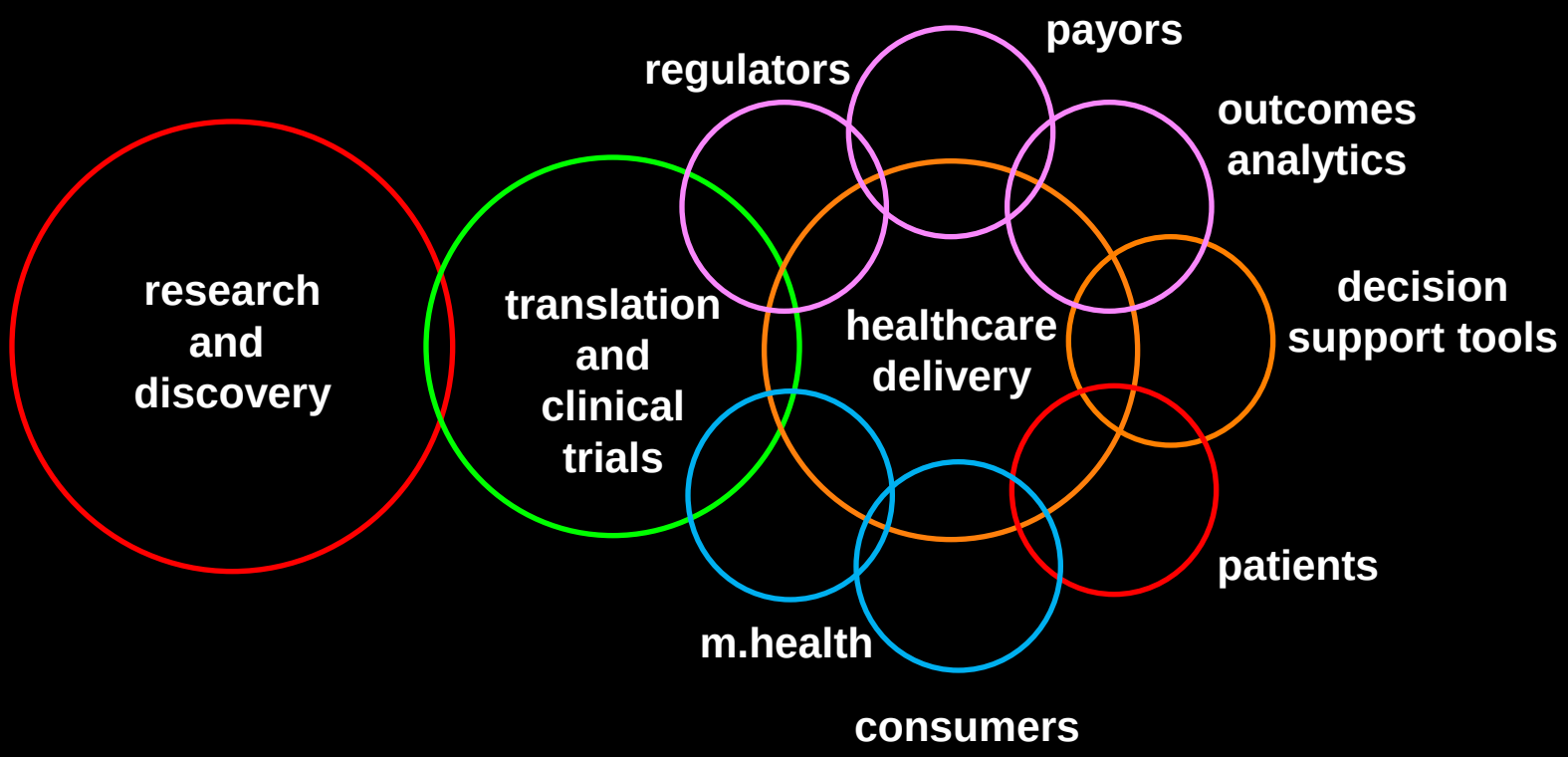




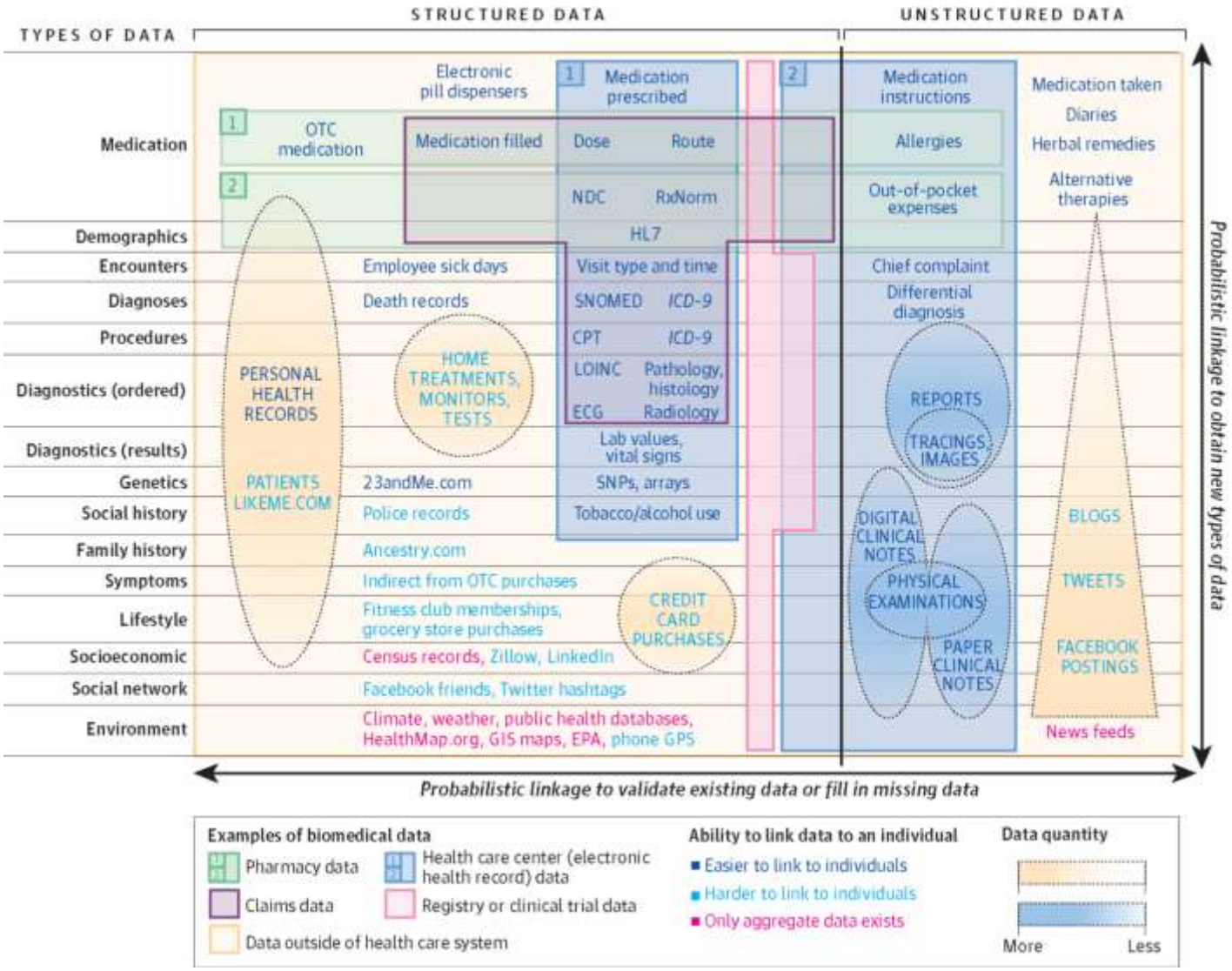

HELL IS THE PLACE WHERE NOTHING CONNECTS — T.S. ELIOT

Silos Subvert Solutions: Protecting Turf and Sustaining the Status Quo

The Need for Facile, Seamless Data Exchange Formats for Large Scale Biomedical Data Systems



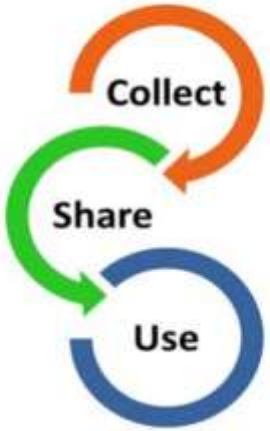
The Diversity of High Value Data Sources in Healthcare: The Integration Challenge



G. M. Weber et al. JAMA. 2014;311(24):2479-2480. doi:10.1001/jama.2014.4228

FEDERAL HEALTH IT STRATEGIC PLAN

2015 – 2020



Prepared by:

The Office of the National Coordinator for Health Information Technology (ONC)
Office of the Secretary, United States Department of Health and Human Services
http://healthit.gov

The Office of the National Coordinator for Health Information Technology

Connecting Health and Care for the Nation:

A 10-Year Vision to Achieve an Interoperable Health IT Infrastructure

Overview

The U.S. Department of Health and Human Services (HHS) has a critical responsibility to advance the connectivity of electronic health information and interoperability of health information technology (health IT). This is consistent with its mission to protect the health of all Americans and provide essential human services, especially for those who are least able to help themselves. This work has become particularly urgent with the need to address the national priority of better and more affordable health care, leading to better population health. Achieving this goal will only be possible with a strong, flexible health IT ecosystem that can appropriately support transparency and decision-making, reduce redundancy, inform payment reform, and help to transform care into a model that enhances access and truly addresses health beyond the confines of the health care system. Such an infrastructure will support more efficient and effective systems, scientific advancement, and lead to a continuously improving health system that empowers individuals, customizes treatment, and accelerates cure of disease.

In the past decade, there has been dramatic progress in building the foundation of a health IT infrastructure across the country that is resilient and flexible to accommodate many types of change. Through deliberate policy and programmatic action, the majority of meaningful use[1] eligible hospitals and professionals have adopted and are meaningfully using health IT. This progress has laid a strong base upon which we can build. However, there is much work to do to see that every individual and their care providers can get the health information they need in an electronic format when and how they need it to make care convenient and well-coordinated and allow for improvements in overall health. There is no better time than now to renew our focus on a nationwide, interoperable health IT infrastructure – one in which all individuals, their families, and their health care providers have appropriate access to health information that facilitates informed decision-making, supports

[1] Formally referred to as the Medicare and Medicaid EHR Incentive Programs

Healthcare as a Complex Information Ecosystem

From Fragmented Silos of Reactive Incident-Centric Care to Systems-Based Integrated Frameworks for increasing Proactive Management of Individual Risk

The Pending Zettabyte Era
1,000,000,000,000,000,000,000

Managing Big Data in Biomedicine is Not a Simple Extrapolation from Current Practices

Current Institutional Structures and Competencies Are Ill-Prepared for Pending Disruptive Change

Biomedical R&D and Clinical Medicine: an Unavoidable Transition to Data and Computation Intensive Methods

Current Era

- opinion-rich, information content-poor
- qualitative, descriptive data
- fragmented care provision and flawed clinical decisions

Biomedical R&D and Clinical Medicine: An Unavoidable Yet Essential Transition to Data- and Computation-Intensive Processes

The Pending Era Massive Data: V5 and D3

- V5: volume, velocity, variety, veracity, value
- D3: dynamics, dimensionality, decisions
- new machine-based analytics for management of mega-metadata, customized distribution and decision-support

The Future of ‘Search’ and ‘Retrieval’

Deep Understanding of Content and Context

Collapse ‘Time to Decision’: Intelligence at Ingestion

Automated and Proactive Analytics:
Why Wait for the Slow Brain to Catch Up to the Fast Machine

The Pending Era of Cognitive 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 Extended Cognosphere:
Automated Analytics, Robotics and Machine Intelligence

Massive Computing Power and Analytic Parsing

• mega-meta data • open source data • personalized data

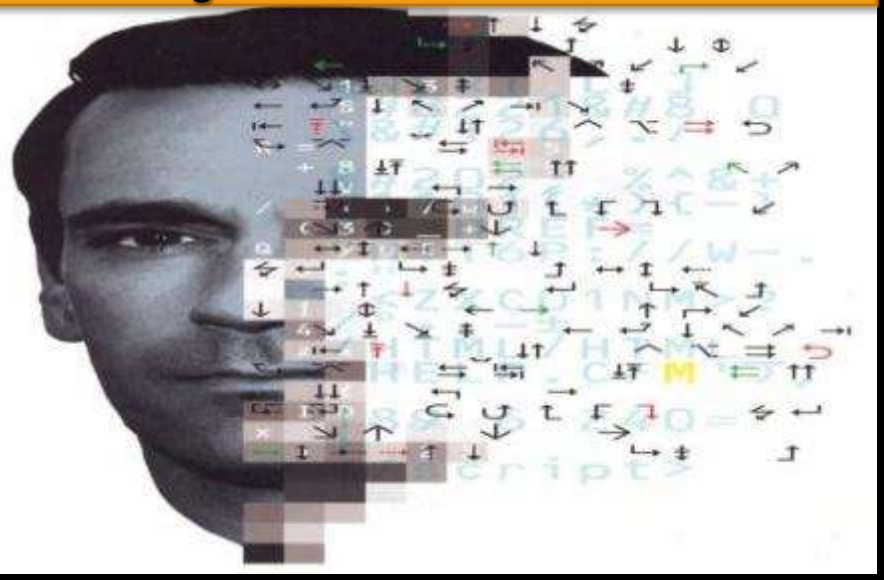
• data science • decision science • data security

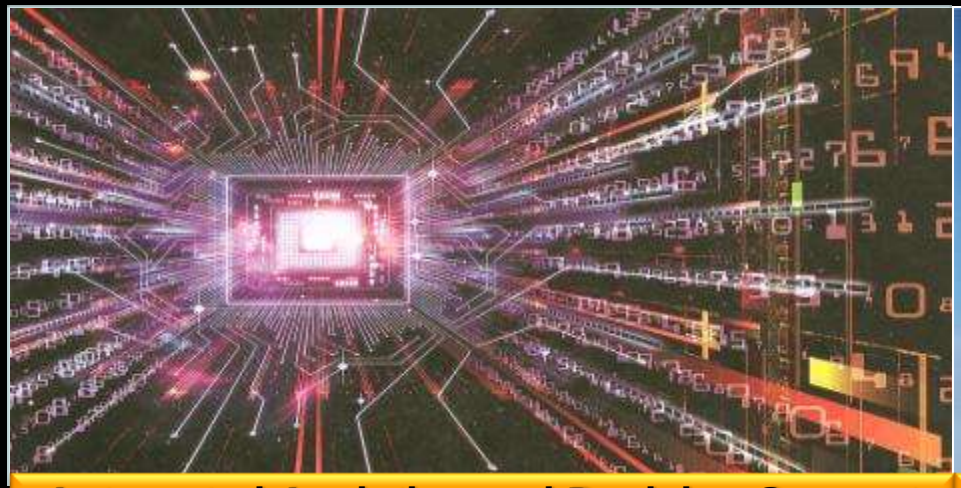
The Growing Education and Knowledge Gaps in Comprehension of Molecular Medicine Concepts By Healthcare Professionals

Technology Acceleration and Convergence: The Escalating Challenge for Professional Competency, Decision-Support and Future Education Curricula

Data Deluge

Cognitive Bandwidth Limits



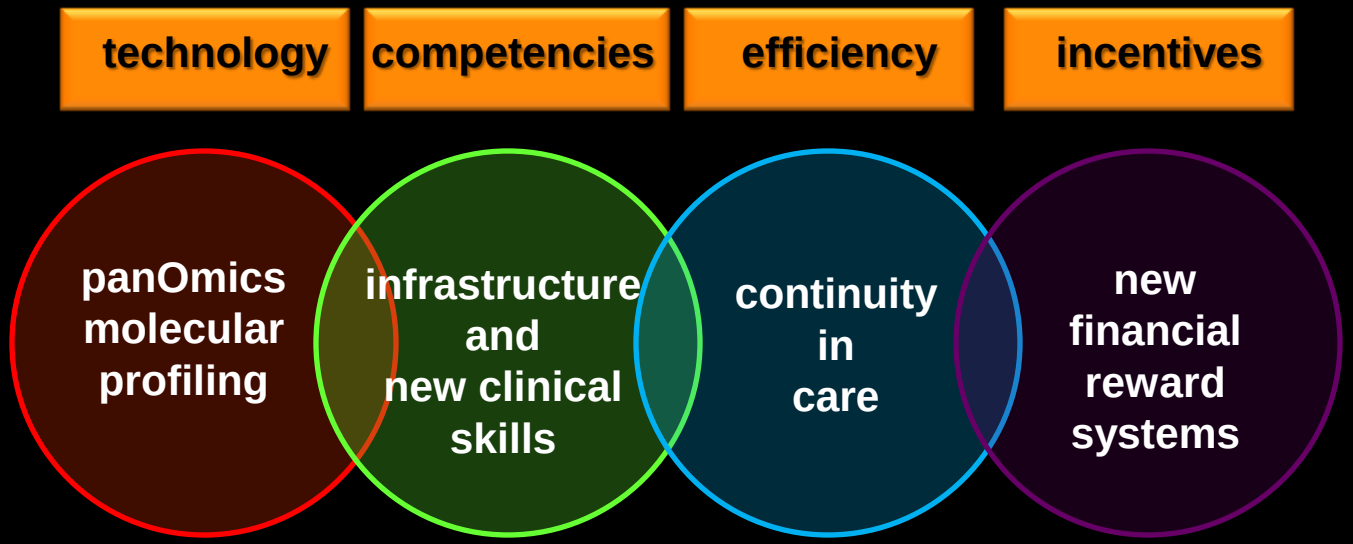


Automated Analytics and Decision Support

Facile Formats for Actionable Decisions

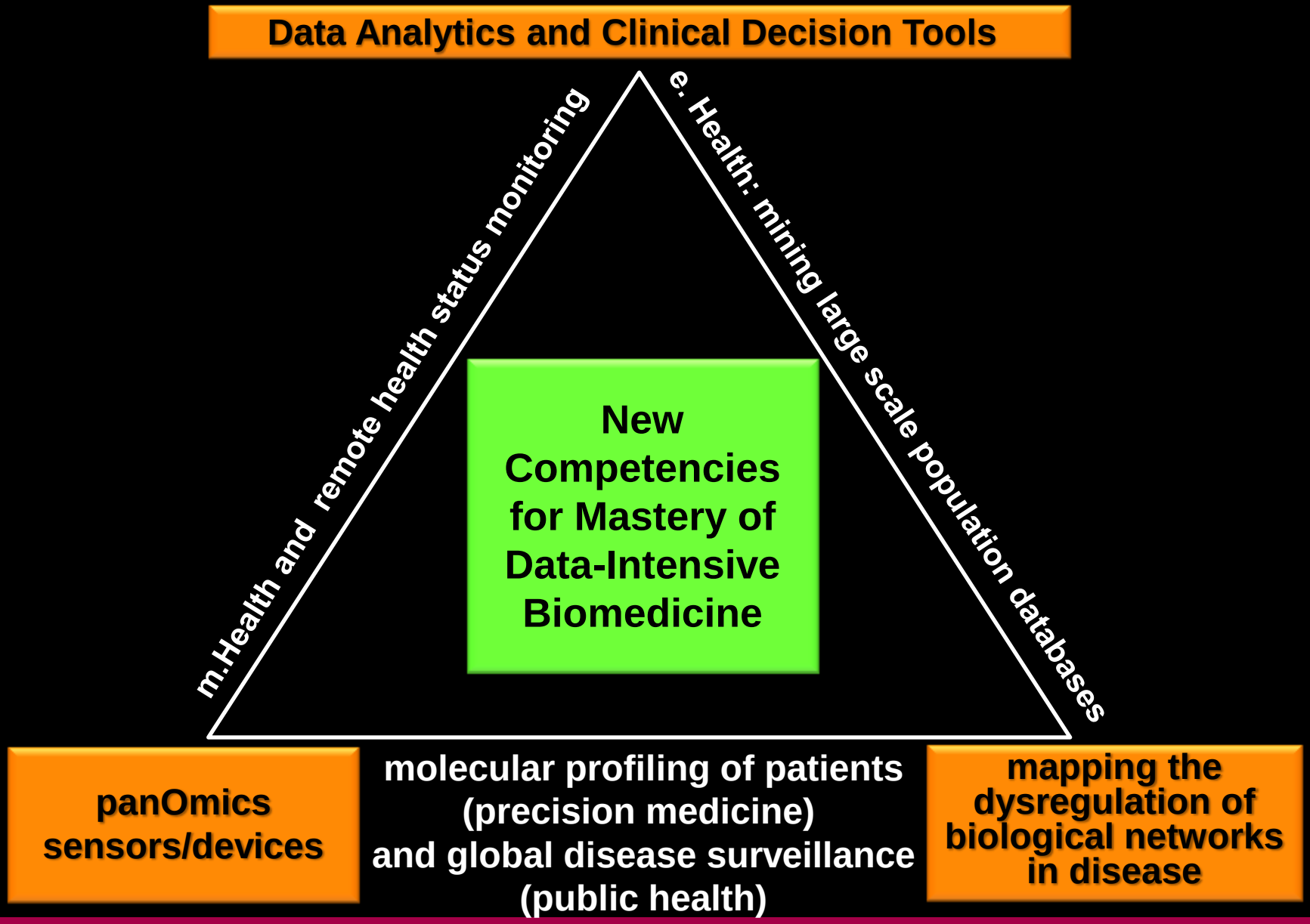
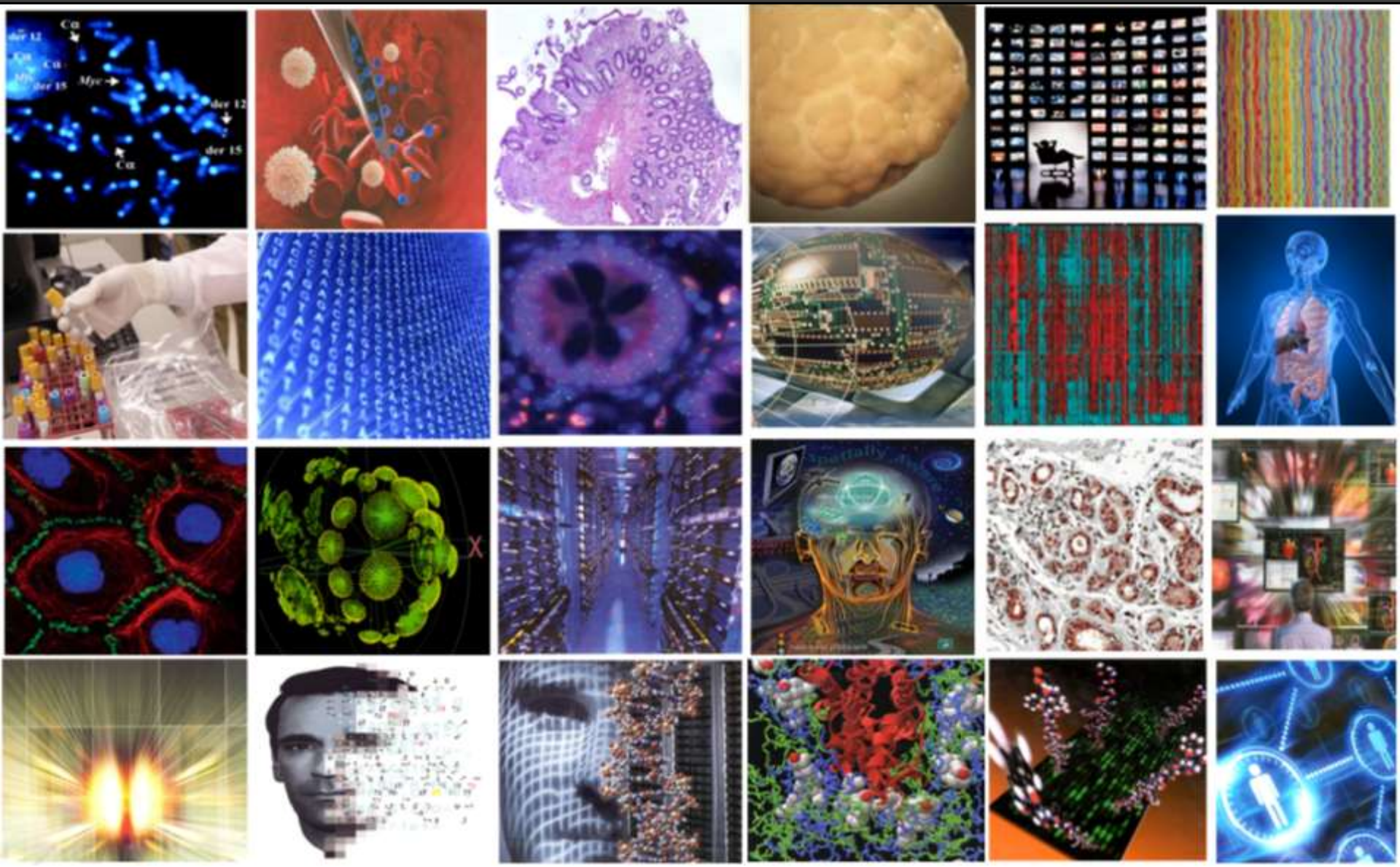
CHANGE
is good
you go first

Leveraging the Potential of Precision Medicine Will Require PROFOUND CHANGES in the Organization and Proficiency of Healthcare Services



- seamless integration of healthcare data for real-time access and improved care decisions
- shift form reactive episodic care encounters to increasingly proactive risk mitigation
- progressive shift from management of overt disease to sustained wellness

Building Knowledge Networks to Improve Individual Health and Sustainable Healthcare Systems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