Biomarkers, Biosignatures and Molecular Diagnostics: Key Value Drivers for Precision Medicine, Improved Healthcare and Maximizing Wellness

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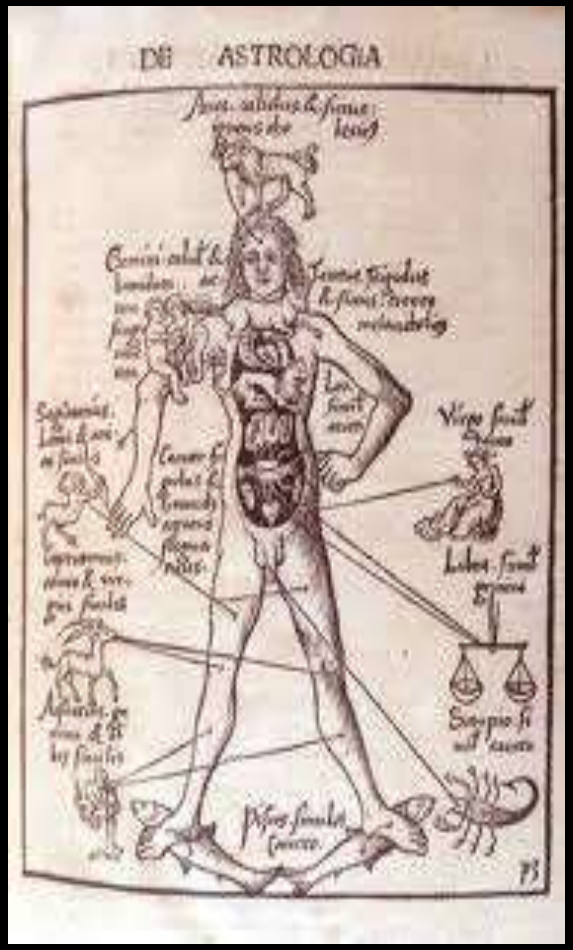
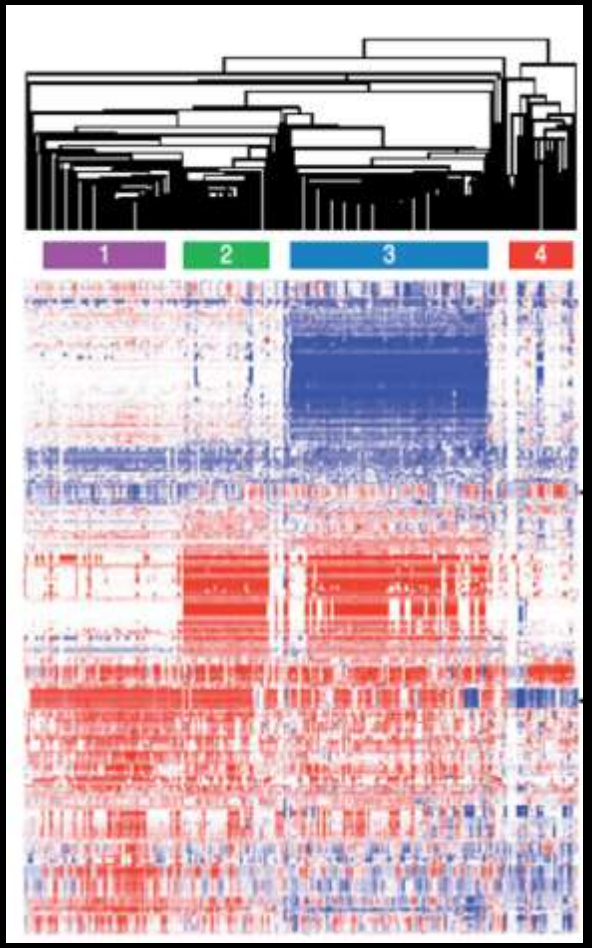
Presentation at: National Biomarkers Development Alliance Launch Symposium

The National Press Club, Washington DC 20045

January 13, 2014

Medical Progress:
From Superstitions to Symptoms to Signatures

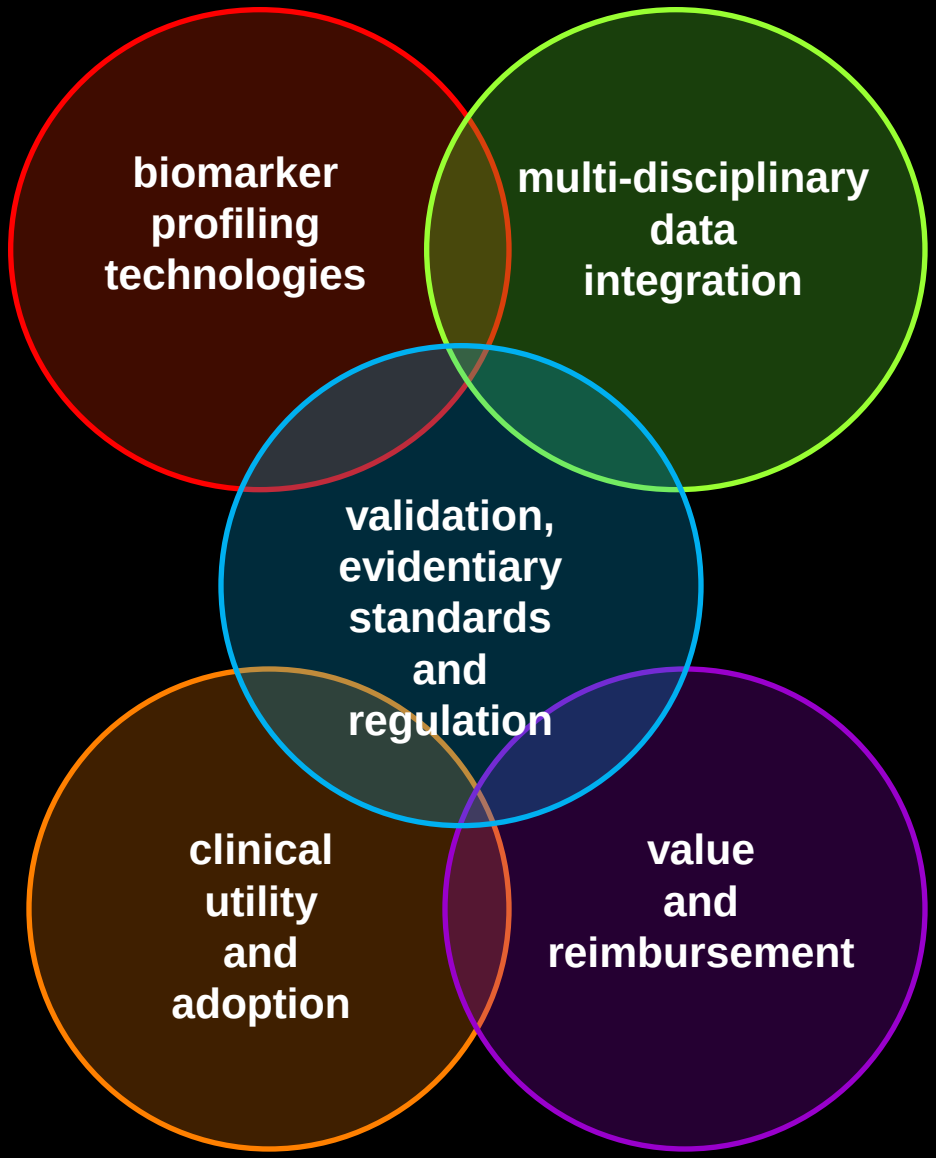




Biomarkers, Molecular Diagnostics (MDx) and Precision Medicine

- the potential economic and health benefits from biomarkers transcend any other current category of healthcare innovation
  - increased diagnostic accuracy
  - rational treatment selection
  - monitoring treatment efficacy
  - health monitoring and optimized wellness
  - earlier detection of treatment resistance

Identification and Validation Biomarkers: A Complex, Multi-Dimensional Challenge



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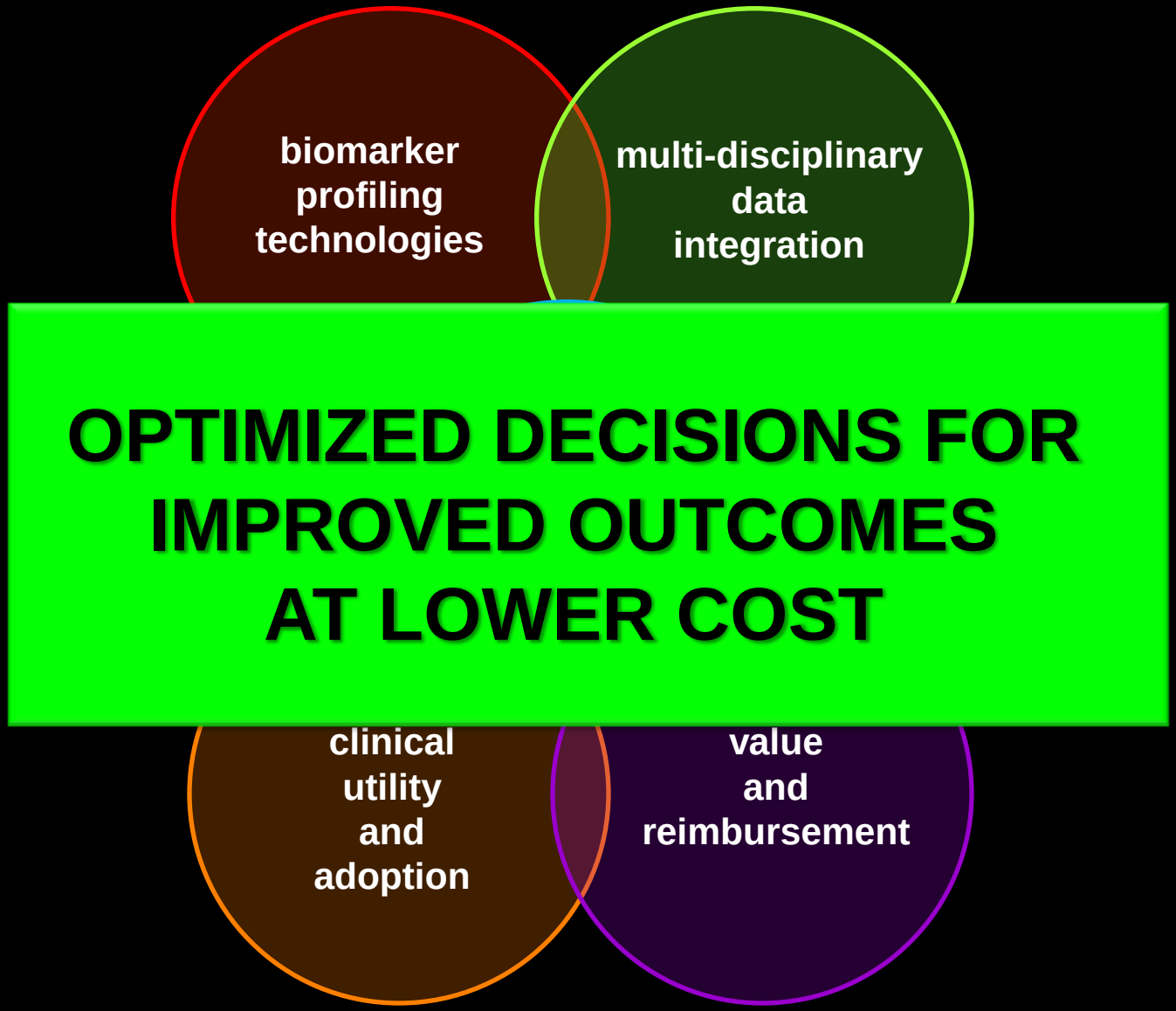
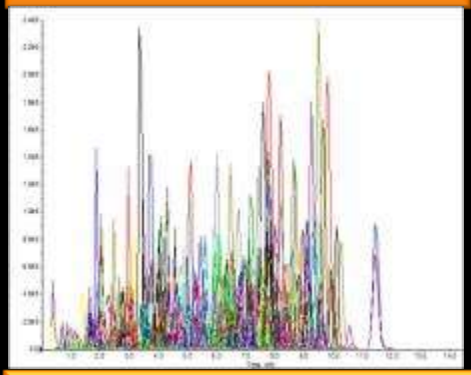


The Evolution of Clinical Diagnostic Testing in The Pending 'Omics Era and New Device Technologies

Unianalyte Tests

Multianalyte Biomarkers

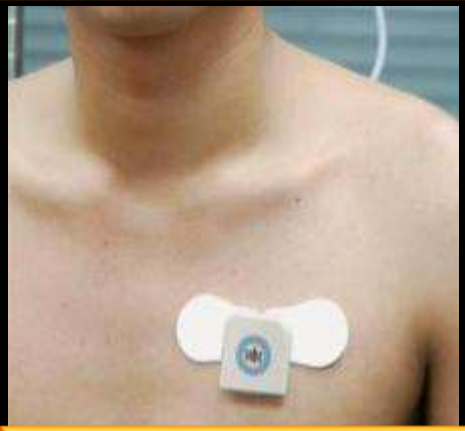


Whole Genome Sequencing

New Regulatory and Reimbursement Policies

Centralized Testing, Large Capital Base Instrumentation

On-Body: In-Body Sensors



Portable, Point of Need Diagnostic Devices

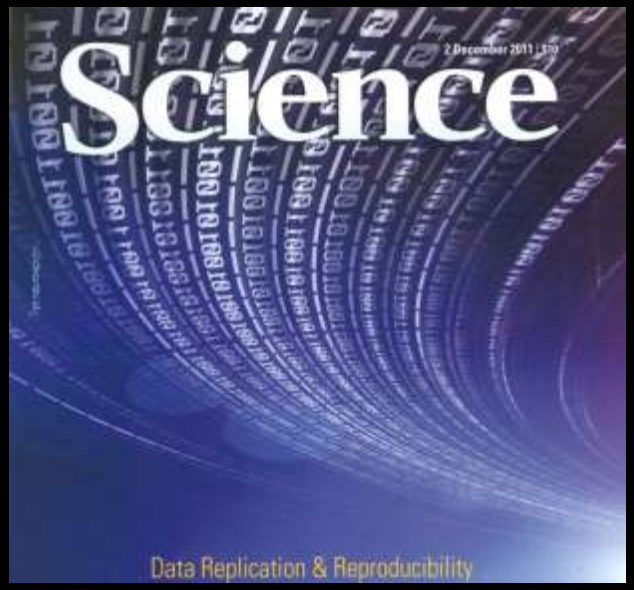
Increasingly Distributed Data Feeds and Real Time Health Monitoring

The Imperative for Integrated End-to-End Systems Approaches in Biomarker R&D

The complexity of multiplex biomarker discovery, clinical validation and regulatory oversight is comparable to (bio)pharmaceutical R&D

In common with R&D for drugs and vaccines, solutions to complex multi-dimensional technical challenges require systems-based approaches

Sloppy and Unstandardized Science:
The Growing Problem of Poor Reproducibility in Biomedical Publications



Garbage Data, Fragmented Data, Selfish data and Untapped Data: Pervasive Deficits in Academic Biomarker "Discovery"

- publish and vanish: disturbing low reproducibility of academic publications
- poor access to rigorously annotated biospecimens from stringently phenotyped patients plus outcomes data
- insufficient control of pre-analytical parameters and poorly standardized analytical methods
- idiosyncratic 'lab-specific' analytical methods
- 'small N' studies lacking statistical power

Garbage Data, Fragmented Data, Selfish data and Untapped Data: Pervasive Deficits in Academic Biomarker "Discovery"

- chaotic data reporting formats and poor database interoperability
- pressure to publish
- poor compliance with funding agency/journal policies on open data sharing and full data disclosure
- failure to work to (or understand) industry and regulatory standards

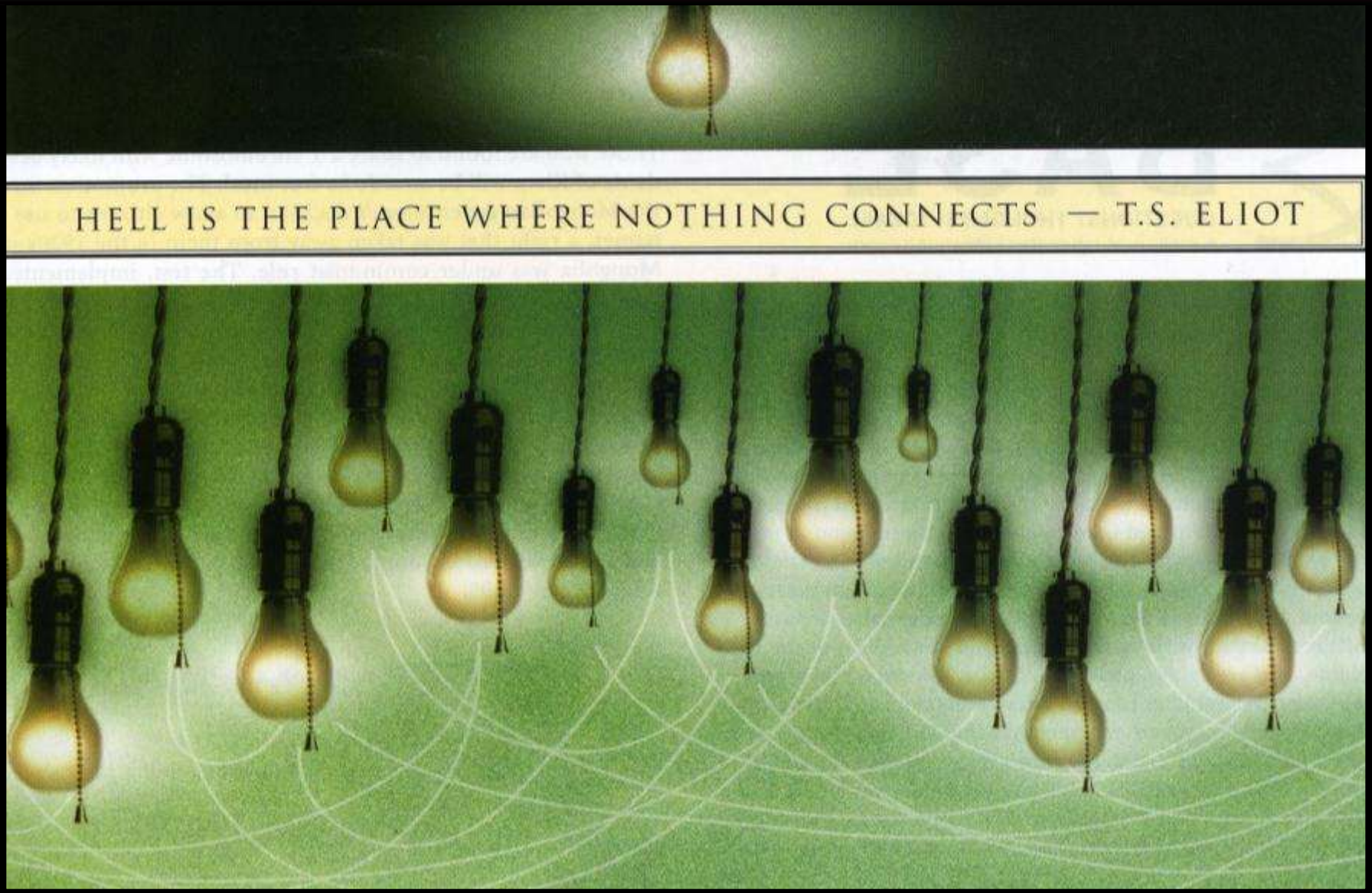
Access to High Quality Biospecimens, Biobanks and DNA Repositories: An Obligate Prerequisite to Productive Validation of Putative Causal Disease Markers

academic anecdotes and wasted investment?

or

requisite scale and stringent QA/QC standards?

Data Silos and Data Tombs



Data Silos and Data Tombs

Thinking Ahead

- are we building systems and infrastructure that merely support the collection of data?

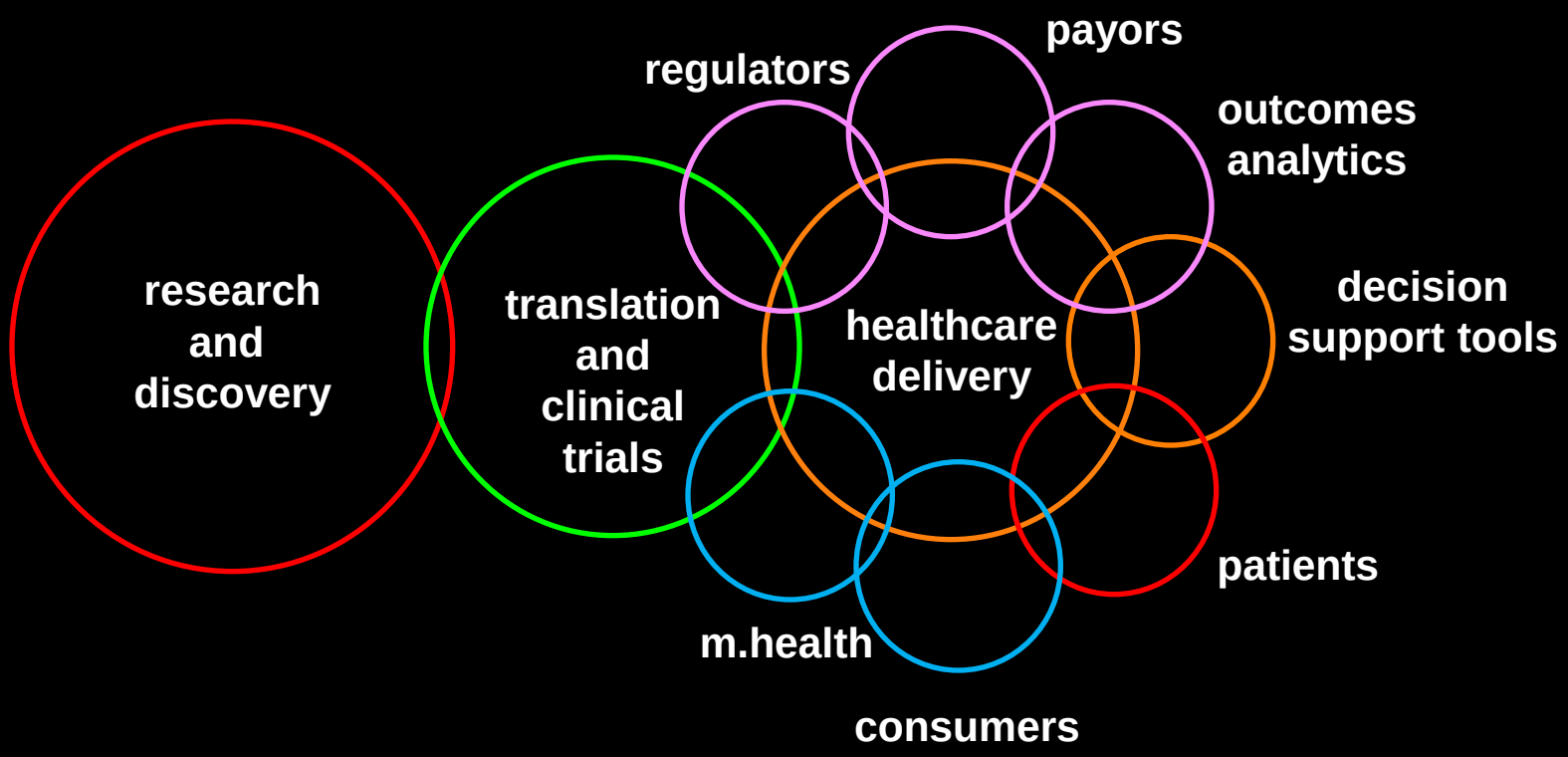
or

- systems to integrate data from early discovery to patient care?

and

- support data validation, sophisticated analytics, evidence generation and decision support systems to optimize patient care and drive a learning healthcare enterprise?

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



Biomarkers, Disease Subtyping and New Clinical Trial Designs and Regulatory Frameworks

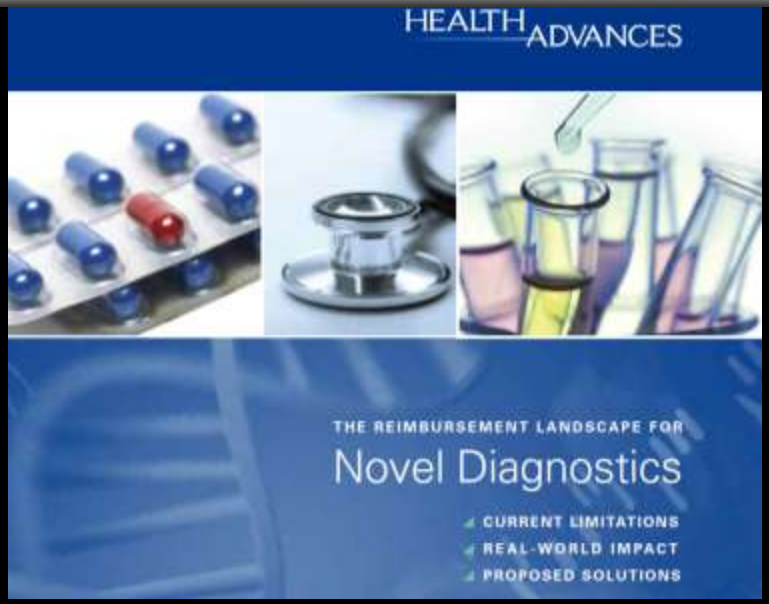
- the demise of the all-comers trial design?
- new trial designs based on biomarker-selected patient cohorts and Rx response evaluation
  - enrichment trials, adaptive trials
  - multi-agent trials and more agile shifts in combination Rx
- regulatory engagement and leadership

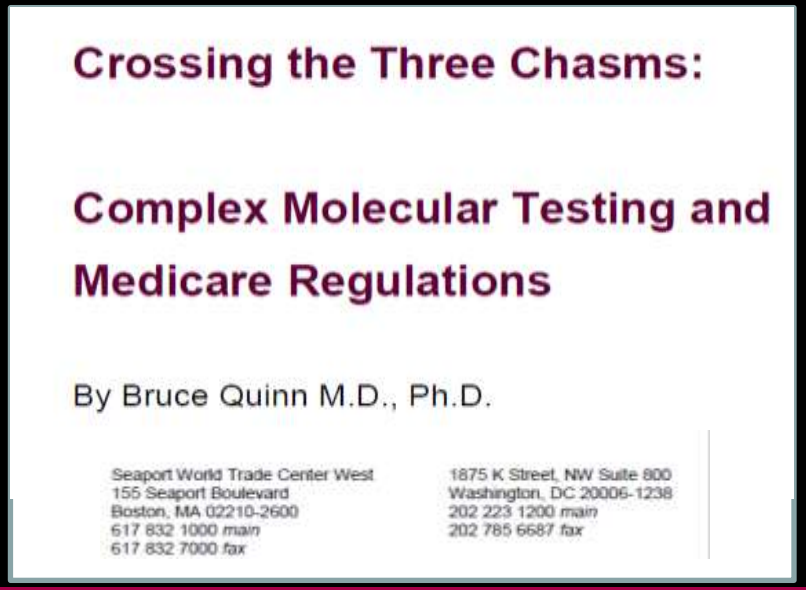
The Vital Role of Patients and Patient Advocacy Organizations

Interactive Patient-Centered Initiatives (PCI)

- new opportunities to share, mine and integrate data on a larger scale
  - research, clinical trials, outcomes analysis
- build new biorepository networks of well curated and standardized samples to support research
- faster accumulation of large sample collections to achieve necessary statistical power
- “matchmaking” for more proficient research study/clinical trial recruitment

Educating Payors on the Value of Biomarkers in Healthcare: Shift from Cost-Based Pricing to Value-Based Reimbursement to Incentivize Biomarker R&D





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

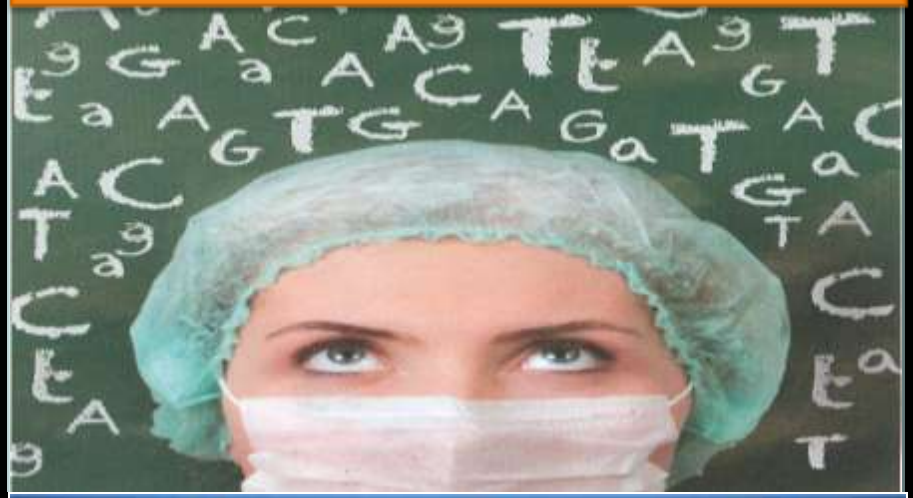
Managing Big Data in Biomedicine is Not a Simple Extrapolation from Current Practices

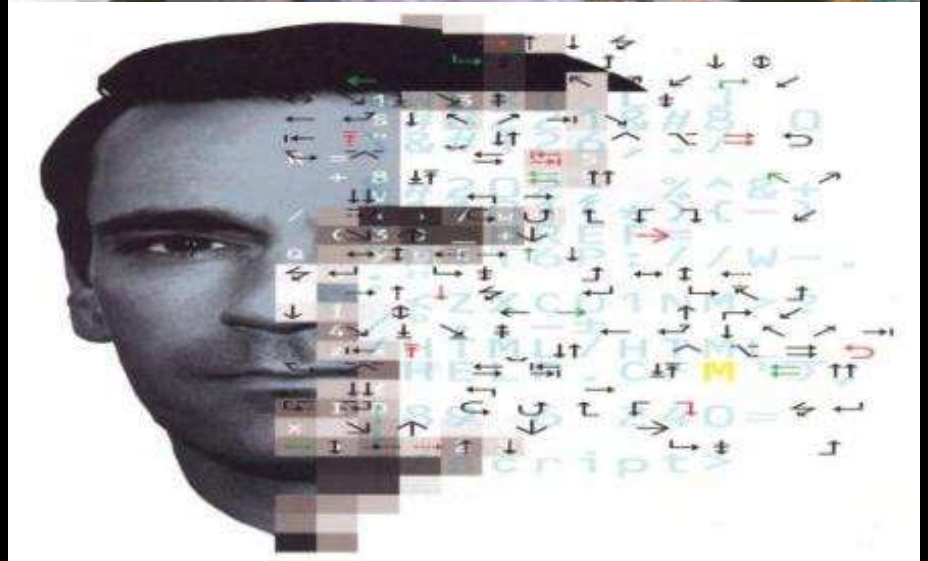
Current Institutional Structures and Competencies Are Ill-Prepared for Pending Disruptive Change

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

Data Deluge

New Science and Cognitive Bandwidth



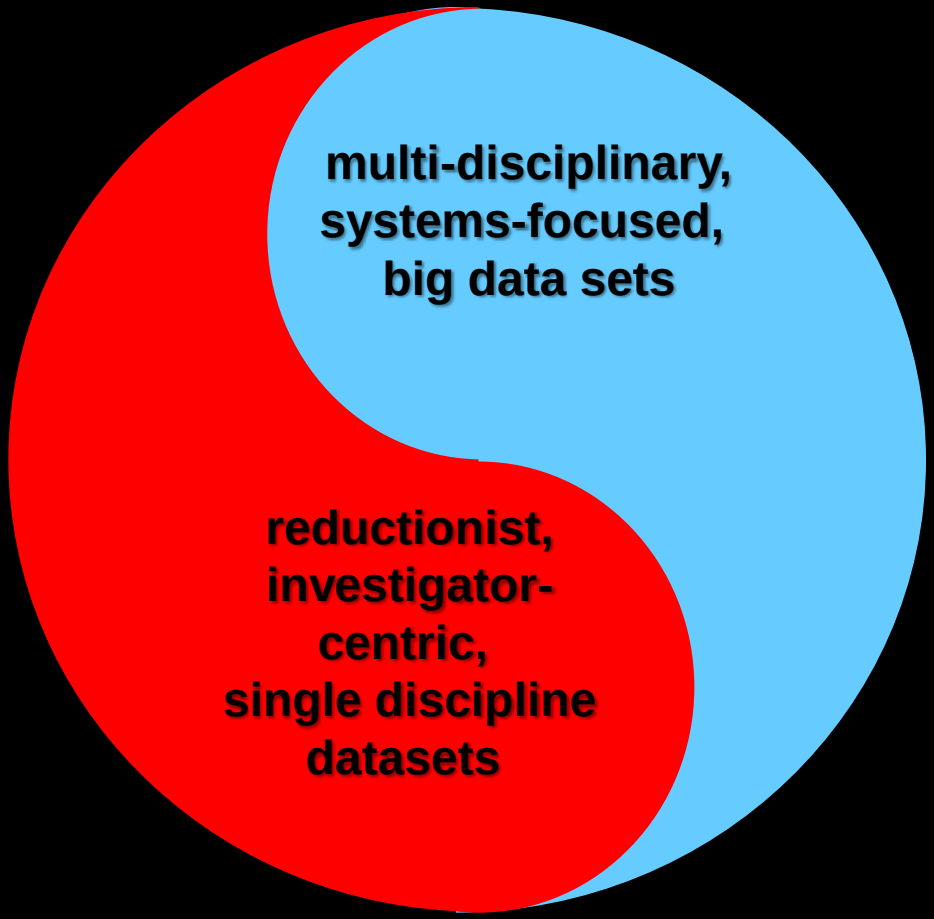


Automated Analytics and Decision Support

Facile Formats for Actionable Decisions

21st Century Knowledge Networks versus 20th Century Organizational Structures

Cross-Domain Convergence, Complexity in Biomedicine and Increasing Dependency on Data-Intensive Methods and New Knowledge Networks



unbiased datasets and new analytics for pattern mining

hypothesis driven research

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STANDARDS

SILO-BUSTING

SYSTEMS-BASED KNOWLEDGE NETWORKS

From Silos to Systems

single discipline, single investigators	multi-disciplinary teams
single institution activities/resources	large scale collaboration networks
academic isolation	academia-industry-healthcare provider networks
erratic quality qualitative data	reproducible quantitative data
fragmented data	integrated data
incompatible data formats	data interoperability from discovery to clinical care

From Silos to Systems

- unshared data: "data tombs"
- dominance of ROI grant policies
- passive patient engagement
- cost-based reimbursement for molecular diagnostics




- open, shared data and compliance with deposition commitments
- redirect more grants to networked systems projects
- engaged patient advocacy groups for faster progress: biorepositories/ clinical trials/ outcomes analysis
- value-based pricing for molecular diagnostics and information services

Realizing the Potential of Biomarkers in Healthcare

- more than proficient adoption of new technologies
- depends equally on major reforms in current approaches to the organization and funding of biomarker discovery and validation
- new reimbursement and market incentives for commercial investment

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- completed two year in-depth analysis of obstacles and opportunities for biomarkers in biomedicine
- multi-sector engagement
  - researchers, clinical trialists, statisticians, informaticians
  - healthcare providers and patients
  - regulators and payors
  - private sector (Rx, MDx, computing)
- urgent imperative for strategic vision and national leadership to integrate cross-disciplinary and trans-sector actions
- new framework for long overdue change

Slides available @ http://casi.asu.edu/