Computational Technology for Effective Health Care: Immediate Steps and Strategic Directions

Computer Science and Telecommunications Board

National Research Council

of the National Academies

Chartered by the National Library of Medicine

Project Scope

Examine information technology challenges faced by the health care system in realizing the emerging vision of patient-centered, evidence-based, efficient health care using electronic heath records (EHR) and other IT.

Focus on the foundation issue of the EHR.

Committee Membership

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- Alfred Spector, Google, Inc.
- Peter Szolovits, Massachusetts Institute of Technology
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- Gio Wiederhold, Stanford University

Evidentiary Basis for Study

- Previous work of the Institute of Medicine (IOM) on a vision for 21st century health care —
- Work by IOM and National Academy of Engineering on a systems view of health care
- Site visits to acknowledged leaders in health care IT on the theory that many important innovations and achievements for health care IT will be found in such institutions
- Selective literature review
- Committee member expertise

Site Visits

- University of Pittsburgh Medical Center
  Pittsburgh, PA
- Veterans Administration
  Washington, DC
- HCA TriStar
  Nashville, TN
- Vanderbilt University Medical Center
  Nashville, TN
- Partners Healthcare
  Boston, MA
- Intermountain Health Care
  Salt Lake City, UT
- University of California, San Francisco
  San Francisco, CA
- Palo Alto Medical Foundation
  Palo Alto, CA

Central Conclusions

- Current efforts aimed at nationwide deployment of HCIT will not be sufficient to achieve the vision of 21st century health care, and may even set back the cause…
- Success will require emphasis on providing cognitive support (assistance for thinking about and solving problems).
- In the near term, embrace measurable health care quality improvement as the driving rationale for HCIT adoption efforts.

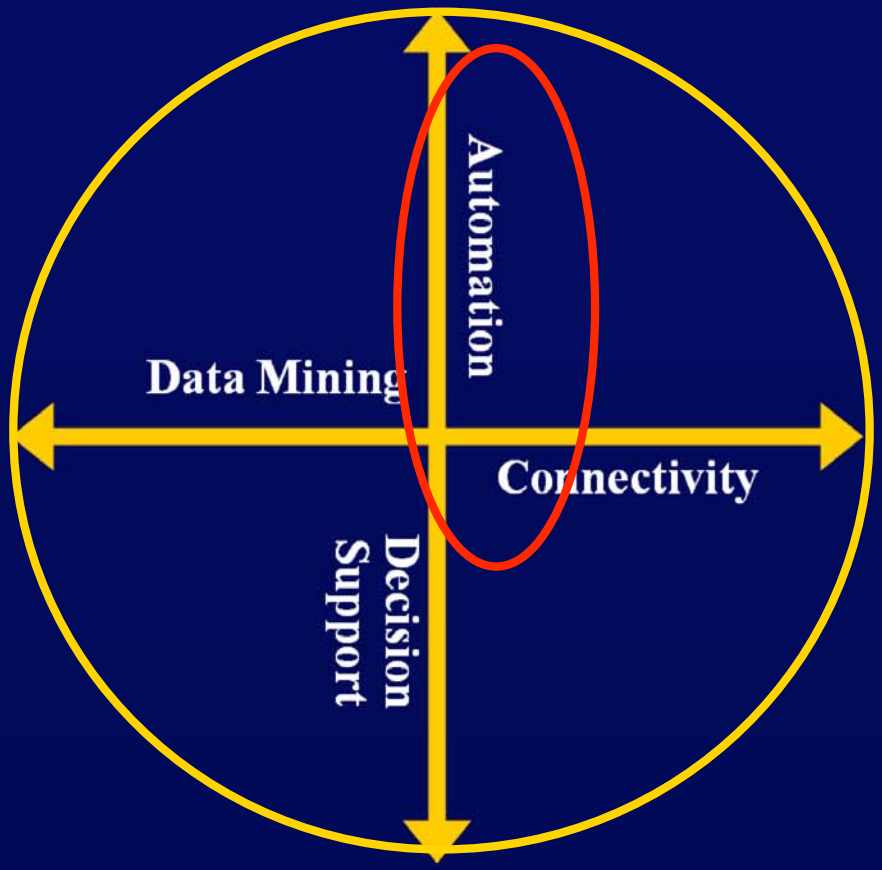
Information-Intensive Aspects of the IOM's Vision for 21st Century Health Care

- Comprehensive data on patients' conditions, treatments & outcomes
- Cognitive support for health care professionals & patients to help integrate
  - patient-specific data
  - evidence-based practice guidelines & research results
- Tools to manage a portfolio of patients & to highlight problems as they arise
- Rapid integration of new instrumentation, biological knowledge, treatment modalities, and so on into a "learning" health care system
- Accommodation of growing heterogeneity of locales for provision of care
- Empowerment of patients and their families in effective management of health care decisions and their implementation

Site Visit Observations

- Patient records are fragmented
- Clinical user interfaces mimic paper without human factors & safety design
- Biomedical devices are poorly integrated
- Systems are used often to document what has been done, after the fact, for regulatory and legal uses
- Support for evidence-based medicine and computer-based advice is rare
- Clinical research activities are not well integrated into clinical care
- Legacy systems are predominant
- Centralization is the predominant method of standardization
- Implementations timelines are long and course changes are expensive
- Response times are variable and long down times occur

Imbalance in the Health Care IT Portfolio



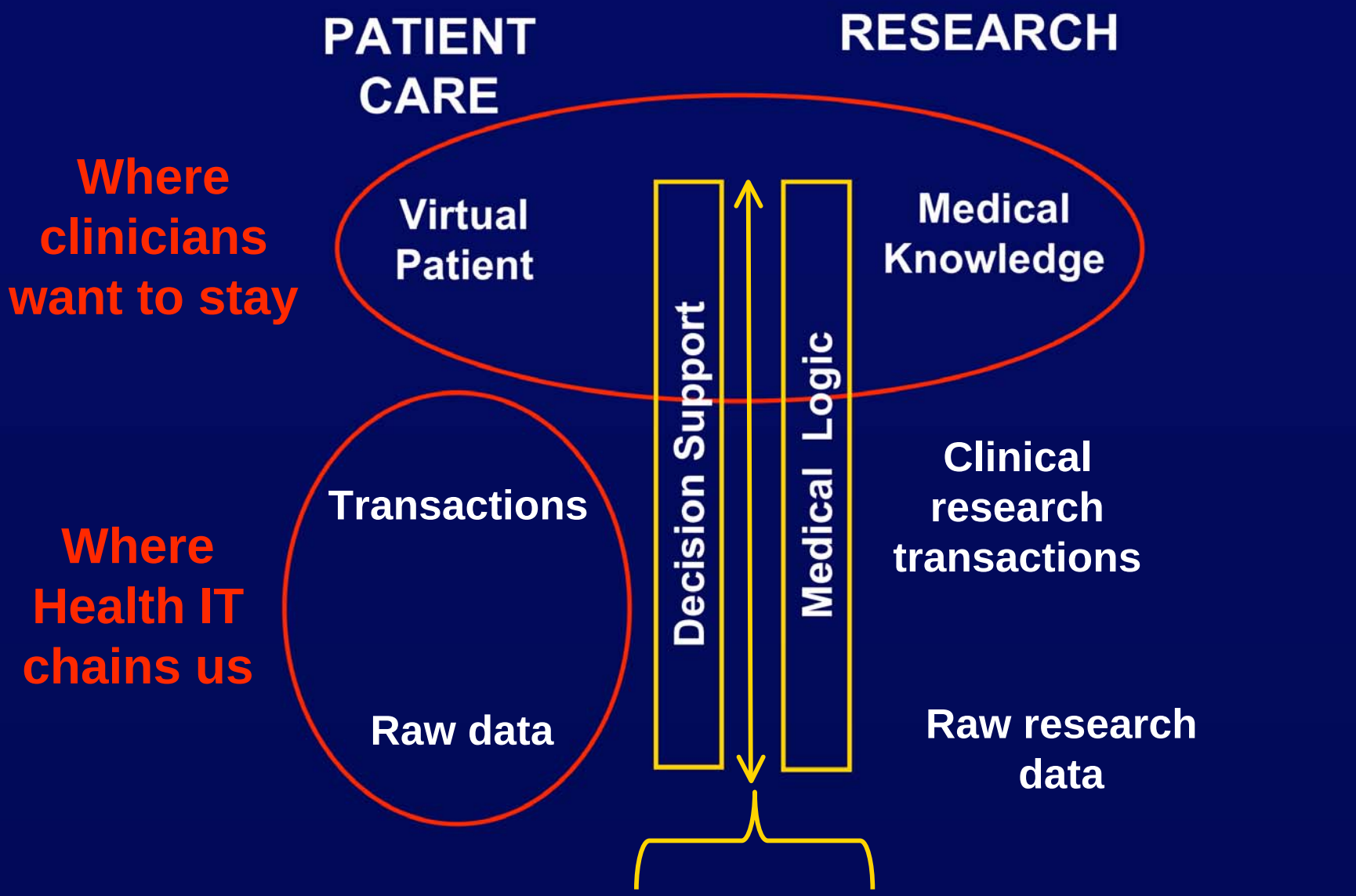
Principles for Evolutionary Change

- Focus on improvements in care - technology is secondary.
- Seek incremental gain from incremental effort.
- Record all available data to drive care, process improvement, and research.
- Design for human and organizational factors so that social and institutional processes will not pose barriers
- Support the cognitive functions of all caregivers, including health professionals, patients, and their families.

Principles for Radical Change

- Architect information and workflow systems to accommodate disruptive change
- Archive data for subsequent re-interpretation
- Seek and develop technologies that identify and eliminate ineffective work processes.
- Seek and develop technologies that clarify the context of data.

Overarching Grand Challenge



Illustrative Research Challenges

- Patient-Centered Cognitive Support
- Modeling
- Automation
- Data sharing and collaboration
- Data management at scale
- Automated full capture of physician-patient interactions

Segmentation of Health-Care-Related Technology Efforts

	General applicability	Health care specific
Relatively clear path forward from existing technologies	*Quadrant 1:* **General – applied efforts**	*Quadrant 2:* **Health care – applied efforts**
Advanced research needed	*Quadrant 3:* **General – advanced efforts**	*Quadrant 4:* **Health care – advanced efforts**

Source: Computational Technology for Effective Health Care: Immediate Steps and Strategic Directions, http://www.nap.edu/catalog/12572.html

Recommendations – Government (1)

- Incentivize clinical performance gains rather than acquisition of IT per se.
- Encourage initiatives to empower iterative process improvement & small-scale optimization.
- Encourage development of standards & measures of IT performance related to cognitive support, adaptability to support iterative process improvement, and use to improve quality.

Recommendations - Government (2)

- Encourage interdisciplinary research in three critical areas:
  - organizational systems-level research into the design of health care systems processes and workflow;
  - computable knowledge structures and models for medicine needed to make sense of available patient data including preferences, health behaviors, and so on;
  - human-computer interaction in a clinical context.

Recommendations - Government (3)

- Support additional education and training efforts at the intersection of health care, computer science, and health/biomedical informatics.
- Encourage (or at least do not impede) efforts by health care institutions and communities to aggregate data about health care people, processes, and outcomes from all sources subject to appropriate protection of privacy and confidentiality.

Recommendations - Computer Science & Engineering Research Community

- Engage as co-equal intellectual partners with other relevant disciplines to understand and solve problems of importance to health care.
- Develop institutional mechanisms within academia for rewarding work at the health care/computer science interface.
- Support educational and retraining efforts for computer science researchers who want to explore research opportunities in health care.

Recommendations - Health Care Organizations

- Organize incentives, roles, workflow, processes, and supporting infrastructure to support opportunities for clinical performance gains.
- Balance the institution's IT portfolio among automation, connectivity, decision support, and data-mining capabilities.
- Develop the data infrastructure for health care improvement by aggregating data regarding people, processes, and outcomes from all sources.
- Insist that vendors supply IT that permits the separation of data from applications and facilitates data transfers to and from other non-vendor applications
- Seek IT solutions that yield incremental gains from incremental efforts.

Not Used

Task

- Two challenges from National Library of Medicine
  - Identify how today's computer science-based methodologies and approaches might be applied more effectively to health care.
  - Explicate how the limitations in these methodologies and approaches might be overcome through additional research and development.
- Very important – engage the computer science research community in meeting these two challenges.

Phase 1

- Engage computer science & engineering researchers through a series of site visits to a variety of health care delivery sites.
- Provide a phase 1 report, based on the site visits
  - Match between today's health information systems and current plans for using EHR nationwide
  - Problems that could be solved relatively easily and inexpensively by today's technologies
  - Illustrate how today’s CS/Eng knowledge could be used to gain short term improvements
  - Important questions that future reports should address

Phase 2

➢ Provide a phase 2 report

- Technical areas where additional H/BMI or CS/Eng research is needed to advance health care IT
- Priorities for research that would yield significantly increased medical effectiveness or reduced cost
- Information management problems whose solutions require new practices and policies
- Public policy questions that need to be resolved to allow such research to proceed

Health Care in the U.S. today

- Fails to deliver the most effective care
- Suffers from medical errors
- Provides unnecessary medical interventions

- Why? The institution of health care is complex and not adequately structured to help clinicians avoid mistakes or to systematically improve their decision making and practice.

- **Tasks and workflow of health care**
  - uncertainty re the patient's medical state and effectiveness of past and future treatments
  - workflows - interruptions, inadequate definitions of roles, poor management of schedules, lack of documentation of steps, expectations and outcomes
  - complex care in a time- and resource-pressured , cost containment environment
- **Institution and economics of health care**
  - number of payers and plans, each with different rules
  - payment incentives (e.g., more compensation for procedures than for communication, diagnosis, preventive care)
  - confusing tertiary care - community hospitals, clinics, primary/specialists, other providers, payers, health plans, information sources

The IOM Vision and the Connection to HCIT

IOM - Health care should be safe, effective, patient-centered, timely, efficient, and equitable (*Crossing the Quality Chasm: A New Health System for the 21st Century*).

Current Implementations of Health Care IT

- Monolithic (even small changes hard to introduce)
- Designed to simply automate processes
- Little support for cognitive tasks of clinicians or for workflow
- Lack of human-computer interaction principles (poor designs that increase chance of error, add to work, and compound frustrations)
  - Can increase workload, and introduce new forms of error that are difficult to detect.

Problems with Today's HCIT

- IT-related activities of health professionals observed by the committee in these institutions
  - rarely well integrated into clinical practice
  - rarely used to provide clinicians with evidence-based decision support and feedback
  - rarely used to support data-driven process improvement; or to link clinical care and research
  - rarely provided an integrative view of patient data
  - often used to document for regulatory compliance and for defending against lawsuits, rarely used to improve clinical care
- Implementation time lines often measured in decades

Four Domains of Information Technology in Health Care

- **Automation-- Use of IT for tasks that can be repeated with little modification (e.g., bar code medication administration, invoices)**
- **Connectivity**
  - **physical infrastructure - connections between various physical facilities to transmit data (e.g., fiber, WiFi)**
  - **Data interfaces for mapping data between systems.**
  - **Connecting people to systems and to each other.**
- **Decision support-- IT to provide information at a high conceptual level to clinicians to facilitate or improve decisions made about care. Includes:**
  - **rule-based alerts (e.g., drug interaction reminders)**
  - **informative information presentation**
  - **statistical and heuristic techniques that reflect an intelligent synthesis of information about the patient, care setting, biomedical knowledge**
- **Data mining-- use of knowledge discovery techniques to analyze various similar or dissimilar datasets to recognize known or unknown relationships. Datasets may include medical literature, multiple patient records, laboratory data (e.g., microarray data).**