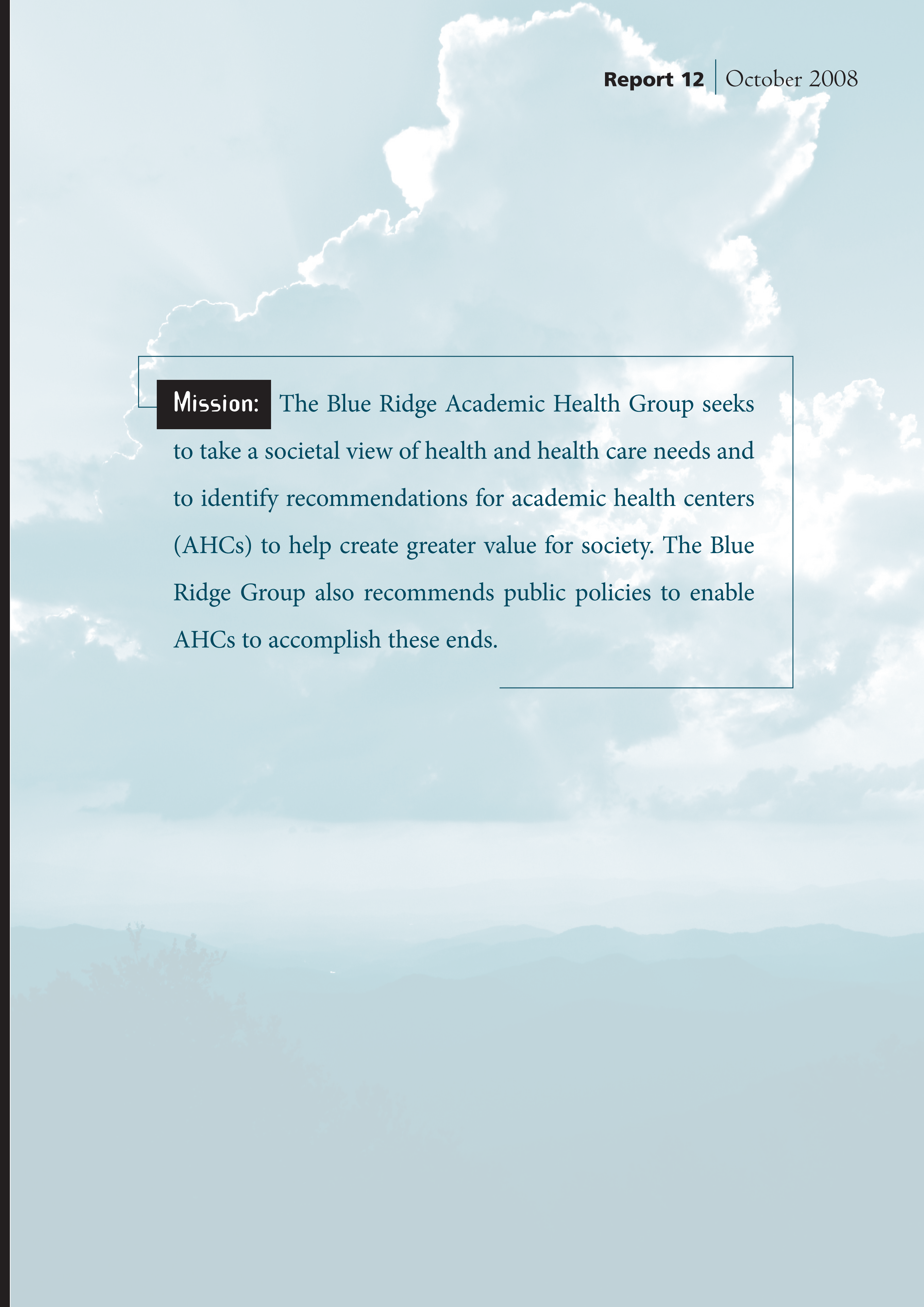
The Blue Ridge Academic Health Group

Advancing Value in Health Care:

The Emerging Transformational Role of Informatics

Report 12 | October 2008



Mission: The Blue Ridge Academic Health Group seeks to take a societal view of health and health care needs and to identify recommendations for academic health centers (AHCs) to help create greater value for society. The Blue Ridge Group also recommends public policies to enable AHCs to accomplish these ends.

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Prelude

The Blue Ridge Academic Health Group (Blue Ridge Group) is committed to furthering the development and fulfilling the promise of health information technology (HIT), in keeping with our vision of a "value-driven" health care system. (Blue Ridge Group 1998b) A value-driven health care system is premised on the principle that a healthy population is a paramount social good. A health system focused intently on this objective would achieve individual and population health through prevention, preemption of disease and disability, cost-effective diagnosis and treatment. Collaboration, competition engendered by transparent evidence-based performance standards, and appropriate rewards would motivate providers, payors, and patients, as well as states and communities to attain and maintain good health and achieve ever-increasing levels of safety, quality, efficiency, and professionalism in the pursuit of health and healing. Universal and equitable access to evidence-based effective care would help ensure that population health, information, and data management strategies can be implemented in a patient-centered health care environment (Ibid).

Current systems of care have evolved such that they are mostly opportunistic and reimbursement-driven, rather than proactive and value-driven. Many of the shortcomings in our unaligned health care efforts can be traced to non-existent, poor or inaccessible data or information, and the lack of capacity to easily and efficiently share both relevant information and knowledge. We foresee a health care system for this century that continuously develops predictive health capabilities that can preempt and prevent disease - with health interventions that will be aligned with genetic, phenotypic, and related data that enables health care that is "just in time, just for me, and every time."

For more information, visit our web site: http://www.blueridgegroup.org.

Introduction

SINCE THE PUBLICATION IN 1999 OF THE INSTITUTE OF MEDICINE'S SEMINAL report, *To Err is Human,* followed by its 2001 report, *Crossing the Quality Chasm,* improving both the quality and safety of health care have been major foci of health policy and practice (IOM 1999 and 2001). Much has changed since then. Computational and information technologies have proliferated, and communications technology centered on the World Wide Web have seen tremendous growth. The advancement and adoption of health information technology (HIT) is seen as indispensable to achieving the highest levels of quality and safety in health care. Such technologies -- everything from electronic health records (EHR) systems, to computer-assisted clinical decision support, to vast genomic data warehouses and powerful data-mining capabilities -- promise efficiency, automation, effectiveness, transparency, decision-support, personalization, portability, and consumer empowerment, with multiple and fast-improving opportunities to achieve health care quality and safety. This promise was captured in federal policy when the 2003 Medicare Modernization Act established the federal Commission on Systemic Interoperability and charged it with developing a comprehensive strategy for the creation of common HIT standards (http://endingthedocumentgame.gov/). President George W. Bush set a national goal of achieving widespread adoption of EHRs by the year 2014 (White House 2004).

Yet, the early returns on HIT development and implementation are mixed. A recent survey found fewer than 15% of medical group practices using an electronic medical record system (Gans et al. 2005). A more recent comprehensive survey of EHR implementation finds that, as of 2005, only 24 percent of physicians in the USA use an EHR, and only 9 percent used EHR systems that have the important key feature of computerized physician order entry (CPOE) (Ashish et al 2006). The data on adoption of EHRs by hospitals is less reliable, but it is estimated that only about 5 percent of hospitals had CPOE systems as of 2005 (Ibid.) (Han et al, 2006). In an especially troubling finding, one major study found that only 1% of existing HIT systems had capabilities for inter-operability and data sharing with different facilities and systems (Chaudhry, et al 2006). This same study found only four benchmark institutions that "have demonstrated the efficacy of health information technologies in improving quality and efficiency. Whether and how other institutions can achieve similar benefits, and at what costs, are unclear" (Ibid at E-12). Others report adverse consequences of HIT implementation.

With so much at stake, it is imperative that we understand the impediments to HIT development and implementation, and devise strategies that can lead to achieving its promise. Our experiences, research, and deliberations convince us that important advances have been made, valuable lessons have been learned, and robust approaches can be more widely implemented. In this, the twelfth report of the Blue Ridge Academic Health Group, we characterize the impediments to HIT adoption and lessons learned and recommend a roadmap for wider and more successful HIT adoption coordinated with transformation in practice.

Impediments to HIT Adoption

The relatively low rate of adoption of HIT has many causes. Among the most serious impediments are the costs involved and the ongoing uncertainty about what standards will ultimately be adopted for processing and sharing information. Additional factors include:

- practical concerns about whether EHRs actually save time and/or effort;
- whether EHRs can be well-integrated into clinical practice;
- privacy issues;
- the difficulties of system maintenance;
- uncertainties about how to choose among the many competing vendors and systems in the marketplace (Bates 2005).

It is clear also that there are both cultural factors embedded within health care practice and structural issues that suffuse the entire health care system and its financing, that must be addressed (Shortliffe 2005). Another rate limiting step for major HIT advances in clinical environments is the lack of sufficient numbers of well trained clinical, research, and translational informatics professionals, as well as IT technicians.

Additionally, a number of recent studies have shown that there are often unintended adverse clinical consequences that follow the adoption of HIT. Ash et al., for example, reviewed a series of qualitative research studies on the impact of computer physician order entry (CPOE) systems. Their review showed that the adoption of HIT often did not prevent significant errors from occurring (Ash et al 2004). Often cited in accounting for ongoing and new errors were factors relating to the inability of systems to account for the complexity of the actual clinical environment or to align with the actual workflow of clinical care, including the number of judgments that must be made or the amount of information that practitioners and staff must have available and/or factor into their decisions. Human error related to all of these was a significant factor (Ibid).

With the tremendous gains in new biomedical knowledge at the molecular level, combined with applied research in quality measurement and safety, there has been a great deal of entrepreneurial and innovative work on quality and safety in health care in the United States. Space doesn't allow an exhaustive review in this report but some examples deserve mention, including the achievements of the Veterans Administration, a number of telemedicine programs, the successful implementation of a variety of HIT systems in a few exemplary hospitals and practices throughout the nation, new private sector initiatives such as EPIC Express for small practice environments, and the coming into prominence of the science of translational bioinformatics where genomic and phenotypic databases promise to lead us slowly but surely into 'personalized' care, targeted to one's environment and genetic makeup.

David Brailer, the former coordinator of national health information technology, has suggested that the current rate of adoption of HIT could result in having the vast majority of our health system "wired" with interoperable EHRs and related HIT systems within two decades. This is a goal well worth our most devoted efforts and requires that we lay the right foundation now (Interview with Arnold Milstein. 2006. See: http://jdc.jefferson.edu/vbp/vol1/iss3/2/).

A Roadmap Needed

If done properly, HIT holds extraordinary promise. But experience is showing that simply buying and implementing any electronic or digital information and decision support system does not necessarily lead to improved quality, safety or outcomes. In fact, this can lead to problems. The most predictable problems arise where information technologies are simply applied to manage health care processes where quality and safety, and existing cultures and processes, have not been adequately reformed or rationalized. In such cases, new technologies, including electronic health records (EHRs) may simply codify outdated practices and roles or only add new layers of complexity for providers and/or patients without enabling improvements in efficiency, workflow, administration, quality, safety or outcomes (Ash, et al. 2004).

What is the role of HIT and how can it best be developed and implemented?

At its best, health information technology improves care and systems of care ". . .by supplying information when and where it is needed to help people make better decisions, by eliminating communication and process errors, and by analyzing information about the patient in combination with biomedical knowledge to make patient-specific recommendations" (Stead 2007). As with many things, this is more easily said than done. What is needed is a solid understanding of the role of and uses for HIT and then a roadmap for development, implementation, and iterative refinement. It is equally important to understand the related changes required in people's roles and work processes for a successful transformation of health care.

The Science behind HIT

To understand the role of and uses for HIT and then create a roadmap for its ongoing development and implementation, it is important to understand that biomedical informatics is a distinct and emerging science. As defined by Stead, Biomedical Informatics is a science that deals with biomedical information, its structure, acquisition and use. Its cornerstones include:

- Techniques to structure, discover, visualize & reason with information content
- Methods to evaluate systems and their technology components
- Approaches to link people, process & technology together as a system
- Processes for facilitating change (Stead 2007)

Detmer prefers a consistent definition that focuses more on its aspirations. Biomedical and health informatics is an integrative scientific field that draws upon the information sciences & related technology to enhance the use of the knowledge base of the health sciences to improve health care, biomedical & clinical research, education, management, & policy" (Detmer 2003). Other definitions exist. Regardless, this science is working on providing techniques to make information technology work more effectively for people. Not all information technology is based in careful science. Information technologies have specific applications and capabilities. Good IT can be put to bad use and bad IT can be put to good use. A quote from Dean Sittig comes to mind, "We don't need expert systems. We need mediocre systems to keep us from doing stupid things." - The important lesson learned in many health care settings is that the fit between the technologies and the tasks is absolutely critical. A misfit can lead to many unwanted and unintended consequences.

Teaching and Learning in an evolving and changing practice and technology environment

As the Blue Ridge Group set out to explore the role and uses of HIT, a key question came forward: What is a "Prepared Mind" for the world we are entering? We know that at the core of success in developing and deploying HIT is the adoption of new ways of defining work and allocating roles and functions. But a corollary question must also be addressed: How do we teach to an evolving and changing practice and technology environment? How do we organize pedagogically to prepare young learners so that they can utilize the vast amounts of new information that is constantly being produced within an increasingly complex practice and learning environment? How do we transition existing practitioners, educators and researchers into systems approaches to practice that make better use of HIT and lead to development of the next generation of HIT? How does HIT develop within existing practice and training programs? How can it inform and enable better systems and learning in the future?

These are not easy questions to answer. But we can see movement in this direction. In education, for instance, one can begin to see the development of new educational strategies and facilities, that include the use of advanced IT systems, robotics, and biometric modeling. Much more emphasis is being placed on small group and problem-based learning, with focus on team dynamics, leadership and problem solving through networking and continuous feedback. (In a previous report, the Blue Ridge Group has surveyed much of this literature and new educational trends in medical professional development. This is an exciting and critical development for the future of the health professions. See: Blue Ridge Group 2005.) Professional testing and certification organizations are all engaged in examining and refining new standards and testing strategies, all in the context of engaging emerging practice and process improvement as well as informatics technologies and capabilities.

> "Selecting the right subset of information and presenting it in the most effective way for a given problem and person is still an unsolved challenge"
>
> **– Florence V, Masys D AAMC Next Generation IAIMS report 2001**

The future will see more dramatic change. Clearly, within the health professions, there is already considerable discussion of workforce requirements and the changing roles and skills required as we transition more and more towards team practice and value-driven health care (See, e.g., ABIM "Project Professionalism" at: http://www.abim.org/news/publications.aspx). Some redefinition of roles and even definitions of what constitutes a health professional are involved in addressing this question. And a great deal of change is likely in clinical and administrative workflow processes. But certain principles are emerging that can guide thinking and planning in this area.

- We are moving out of a world where an individual can be master of all the facts in a field to one where the individual must be as much a master of relevant information technologies as of the special knowledge and skills in their specialties -- along with strong teamwork and collaboration skills.
- It is likely also that "continuous learning" will take on new meaning in an environment where HIT will provide real-time and customized feedback on the skill sets and preparedness of practitioners, as well as on the efficacy of selected or suggested courses of diagnosis and therapy (Stead 2007).
- At the same time, information technology will be key to reproducible execution by interdisciplinary teams. This will enable and empower team approaches to care and shared learning, reducing dependence on individual memory and skill, while supporting reasoning and decision-making in the face of enormous complexity.

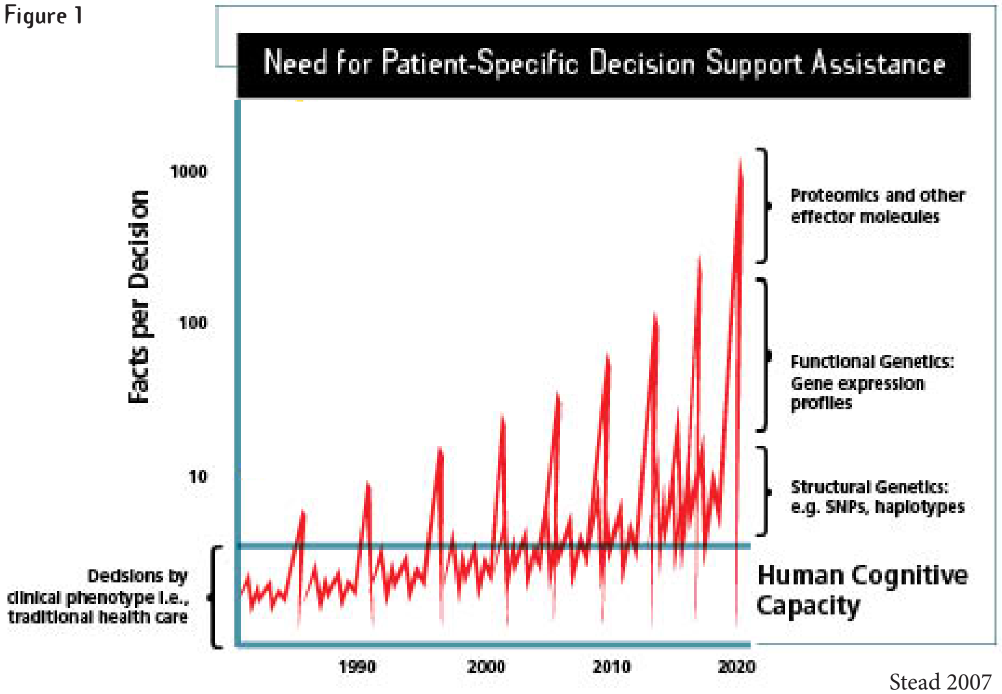
HIT of this sort will reduce the risky reliance on the "heroic individual" and make indispensable and reliable teams of more "equivalent actors" and knowledgeable performers capable of multiplying the efficacy, quality and safety of health care systems (Blue Ridge Group 2007).

Cognitive Limits – We're only Human!

The movement we now see towards training and organizing around shared HIT, better teamwork and more systematic decision-making is not, as some might suppose, simply a fad. Of course, individual expertise and independence of thought continue to be essential to building communities of excellence in practice, research and education. But what in its earliest stages of development and expression might have been a more intuitive sense of the importance of bringing together teams of "equivalent actors" and sharing knowledge and responsibility more broadly, particularly in clinical care, is now acquiring a significant foundation of support in modern cognitive science.

Investigators in cognitive science have shown convincingly that there are significant limits to human cognitive capacity in the forming of judgments and the making of decisions (Miller 1956, Cowan 2000). Further, there is ample evidence that even when we know what to do, we don't consistently follow our own convictions (Campbell et al 2007). ***The startling truth is that modern medicine is already well past the point where the number of facts and factors to be weighed in many clinical decisions can be managed consistently by the unaided human mind and this problem will only get worse with clinical application of advances in genomics and many other areas, as depicted in the following schematic.***

Figure 1



Stead 2007

As Stead has pointed out,

> "The clinician is an integrator, aggregating information from the patient and their record with biomedical knowledge, recognizing patterns, making decisions and trying to translate those decisions into action. Cognitive research has shown that the human mind can handle about seven facts at a time in a decision making process. We are bumping up against that limit today. This cognitive overload is one of the reasons we see the overuse, underuse, and misuse in health care that the IOM has highlighted in the Quality Chasm series. This overload will get worse by one or two orders of magnitude as biomedical research turns functional genomics and proteomics into clinically useful information. We need a new decision making model to deliver reproducible quality in the face of increasingly rich information sources" (Stead 2007).

Managing the (already in many ways unmanageable) complexities of bio-medical and behavioral science and the practice of health care requires new types of organization, systems, understanding and technology that begin with teamwork and shared, integrative processes and systems, and with HIT that can build upon and improve our knowledge and systems. Another relatively new science is beginning to help us with our understanding of complexity and how such growing complexity can be managed and even deployed in ways that can facilitate the development of better systems and knowledge, which in turn can contribute to better quality, safety, and outcomes.

Complexity Science: Health Care as a Complex Adaptive System

Clinicians face a blizzard of information and work in organizations of dizzying complexity. With a knowledge base spanning numerous fields and growing by the minute, it is estimated that a physician in practice would have to read the equivalent of 16 articles per day and review dozens of clinical trials in order to stay abreast of the latest developments in his or her field. And now, increasingly, there are new information technologies that must be mastered, often requiring significant learning and adjustment to the relevant clinical environments and demands. On top of this growing body of knowledge are the multiple skills and tools that must be mastered and the challenge of applying them appropriately and consistently across a variety of environments and conditions.

The science of complexity is just beginning to get a handle on fundamental research issues in complexity science, but can already provide important insights into considerations that must be accounted for in the health care environment, helping to inform our approaches to complexity, including how complex organizations adapt to change (Rouse 2007).

In complexity science, health care is recognized as a complex adaptive system (CAS). Complex adaptive systems present special challenges in terms of organization and control. CASs can be distinguished from traditional organizations, which are amenable to relatively direct command and control. Power is the main currency in a traditional system, whereas influence is the main currency in a complex adaptive system. As defined by Rouse, complex adaptive systems are:

- Nonlinear, dynamic and do not inherently reach fixed equilibrium points. The resulting system behaviors may appear to be random or chaotic, as compared with the apparently more ordered behaviors in traditional systems.
- They are composed of independent agents (like physicians and other relatively autonomous professionals) whose behavior in a system can be described as based on physical, psychological, or social rules, rather than being completely dictated by the dynamics of the system.
- Agents' needs or desires, reflected in their rules, are not homogeneous and, therefore, their goals and behaviors are likely to conflict -- these conflicts or competitions tend to lead agents to adapt to each other's behaviors.
- Agents are intelligent, learn as they experiment and gain experience, and change behaviors accordingly. Thus, overall systems behavior inherently changes over time.
- Adaptation and learning tends to result in self-organizing and patterns of behavior that emerge rather than being designed into the system. The nature of such emergent behaviors may range from valuable innovations to unfortunate accidents.
- There is no single point(s) of control – systems behaviors are often unpredictable and uncontrollable, and no one is "in charge." Consequently, the behaviors of complex adaptive systems usually can be influenced more than they can be controlled (Rouse 2007).

Therefore, complexity science, even at this elementary descriptive level, suggests that conventional means of command and control management cannot be expected to force CAS's to comply with behavioral and performance dictates. The fact that a complex adaptive system is populated by intelligent, self-organizing and relatively autonomous people and groups means that system design, development and evolution can be in many ways unpredictable and uncontrollable. Driving change and the achievement of particular outcomes relies most heavily on incentivization around generally accepted values. There must be sufficient organizational flexibility for adaptation to flourish and changes to emerge. Otherwise, in their natural inclination to "game" the system, actors in every stakeholder domain relevant to such a system will devise "workarounds" to optimize or bypass systems that are not optimal from the their point of view (Rouse 2000, 2003, 2006, 2007a, 2007b).

There are many important implications is this one simple observation for effecting change and improvements in health care systems. Rouse, for instance, compares the health care system with the banking system. Positing them as somewhat analogous complex adaptive systems, he observes the role of the Federal Reserve Bank in the banking system as an absolutely critical management vehicle. The Fed has important mechanisms through which it can exert significant influence on the banking system. Most commonly, it can turn the "knob" of the prime interest rate. With this leverage, and related heft in expert, persuasive influence, the Fed is able to influence the behaviors of banks and investors, who must decide how to react to the Fed's adjustments. The Fed can pretty well predict how the banking system will respond, based on a number of factors critical to the Fed's capacity to make good judgments about adjusting its interest rate "knob." One of the most important factors is having extremely sophisticated, extensive and up-to-the-minute information about virtually all aspects of the banking system.

Rouse believes that the example of the Federal Reserve's role and the mechanism of the prime interest rate knob may have great value as a potential guide for modeling a better future health care system. Rouse believes it is worth seriously exploring the reform of our health system and the adoption of HIT systems that can provide the type of information, access, efficiencies, quality control, privacy and yet transparency, such that the equivalent of "federal reserve agency" for the health care system could be created. Exactly what critical influencing factor(s) could serve as the 'prime mover' mechanism is not yet settled. Candidate factors include reimbursement rates (in relation to the value of health outcomes) or tax rates to providers (lowering rate for providers) who achieve -risk adjusted- high rates of value in terms of patient outcomes and other factors (Rouse 2007).

Organizational Behaviors

	Traditional System	Complex System
Roles	Management	Leadership
Methods	Command & Control	Incentives & Inhibitions
Measurement	Activities	Outcomes
Focus	Efficiency	Agility
Relationships	Contractual	Personal Commitments
Network	Hierarchy	Heterarchy
Design	Organizational Design	Self-Organization

Rouse 2007b

Applying Complexity Science to HIT

In the equally important area of how to develop, implement, and utilize technology systems, complexity science has significant additional insights to offer. The complexities of technological systems themselves play a significant role in how well individuals and institutional stakeholders of every sort can access or process information and acquire the information they need to make right decisions. Information access for patients and families may require one sort of interface (generally one that is relatively simple and with good visual cues). Information and decision support access for health professionals might of necessity require a far more complex interface. And, the complexity of these interfaces will differ from what complexity can be managed by, is essential to, or is useful to, engineers and programmers of such systems; which in turn might be different from that which can be managed by persons involved in data input, analysis, research or pedagogy and learning.

An overriding lesson of complexity science for HIT is that, with information technology as well as our genomic and related bioscience knowledge bases still in early stages of development, underlying HIT systems of necessity will continue to increase in complexity. This increasing complexity must be moved into the background, properly managed by experts and translated into increasingly simple interfaces for the benefit of end-users, whether clinician, technician, patient, or citizen. It is vital that increasing complexity must not be imposed upon the end users, as this will simply undermine the utilization, and potential beneficial effects, of technological advances.

Similarly, further research into CASs should have broad implications for the reform of care processes and workflow. Complexity science and bioinformatics offer still vast uncharted opportunities for informing sense- and way-making in our complex adaptive health care, training and research systems.

Important in this regard is to develop measures and reporting mechanisms that can be most useful to those who are be charged with overseeing and influencing the behaviors and outcomes of the many agents and stakeholders. Far more sophisticated and robust data will be required concerning the processes, behaviors, utilization, efficacy and outcomes of health care practitioners, systems and stakeholders. Some of these data are emerging but their optimal use is far from assured and must be extensively modeled and vetted.

The private sector clearly plays and must continue to play a major role in the development and deployment of HIT. The Bush Administration's initiatives are clearly designed so that the private sector takes the lead in designing innovative systems and developing increasingly common standards. There are many examples of HIT systems being pioneered and implemented in health care-related settings nationwide.

How Should HIT be implemented?

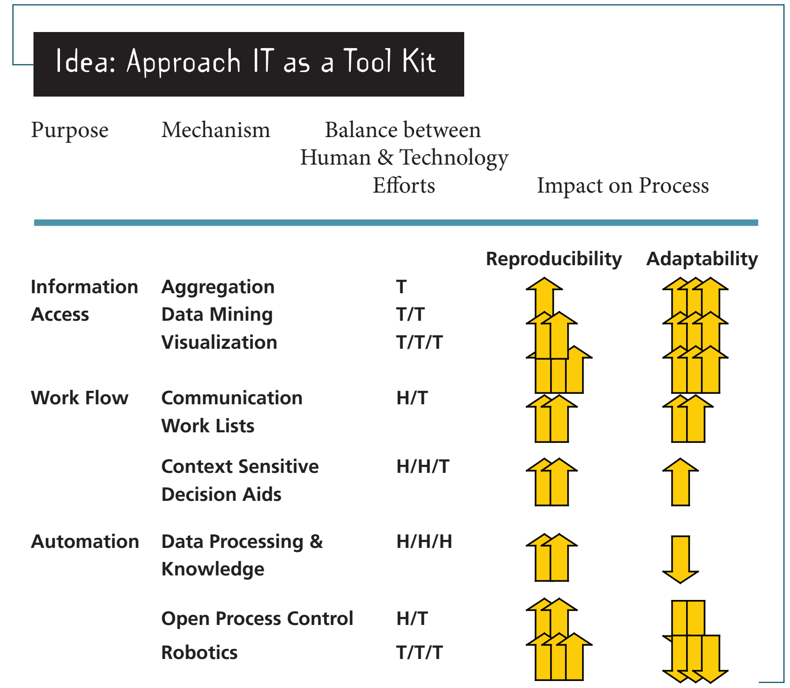
Stead has developed a model for staged introduction of health information technologies into clinical practice, understanding some basic properties of complex adaptive systems. The approach is to think of HIT as a toolkit, matching particular technologies to particular tasks or processes or process improvement objectives in the clinical process, understanding that there is a learning curve associated with any such changes. He suggests starting by using the computer to produce information for humans before introducing approaches that require a person to enter data into the computer during their work. Google is an example of how information, regardless of the original purposes for which it has been generated, can be aggregated and searched to provide new information and to support decision making. Google represents an informatics approach based upon data aggregation and data mining. Already Stead and colleagues at Vanderbilt University are working with HIT systems that enable Google-type functionality in the mining of health records, biomedical information and other essential factors in clinical diagnosis and care (Stead 2007).

From this beginning, Stead proposes a phased process of building IT capabilities that require increasing levels of human inputs but also increasing levels of process automation, along with a built-in feedback loop that factors-in the necessary time and resources for revising both the clinical and technology processes on the basis of experience and testing. A similar staging of the introduction of health IT to the patient is suggested (Stead 2007). This approach is illustrated in figure 2.

In order to make such IT implementation useful in the complex adaptive systems of health care, measures and reporting mechanisms must be developed that can be most useful to those who are be charged with overseeing and influencing the behaviors and outcomes of the many health system agents and stakeholders. Far more sophisticated and robust data will be required concerning the processes, behaviors, utilization, efficacy and outcomes of health care practitioners, systems and stakeholders. Some of these data are emerging but their optimal use is far from assured and must be extensively modeled and vetted.

Again, the private sector clearly plays and must continue to play a major role in the development and deployment of HIT. There are many examples of HIT systems being pioneered and implemented in health care-related settings nationwide. Aggregating and learning from these and building an overall architecture for appropriate data mining and sharing between them should be a national priority.

Figure 2.



Stead 2007

AHC Leadership is Critical to the Advance of HIT for the improvement of Health Care Systems and Outcomes

All of the extraordinary potential for HIT informed by complexity science will go for naught if widespread leadership in reengineering health care processes and HIT implementation is not forthcoming from within our nation's AHCs. As the sources of the workforce pipeline and of new biomedical knowledge, AHCs must lead this transformation. There are some wonderful and compelling examples of both health care process and IT reengineering (see Blue Ridge Report 2007) but not nearly enough. The scope of health care reengineering efforts is admittedly somewhat constrained by larger political and economic realities. And the same can be said for leadership in HIT development. Additional factors contributing to the slow progress were detailed earlier in this report and include such issues as the costs involved and the ongoing uncertainty about what standards will ultimately be adopted for processing and sharing information. Additional factors include practical concerns about whether EHRs as implemented today actually save time and/or effort and can be well-integrated into clinical practice, privacy issues, the difficulties of system maintenance, and uncertainty about how to choose among the many competing vendors and systems in the marketplace (Bates 2005). All of these are legitimate concerns that make it more difficult to devise and commit to an HIT strategy or health care reform mandate. The validity of such concerns does not mean HIT cannot be effective. Instead, they point to where we need better technology design or better processes for incorporating the technology into practice. All leadership and change-making ambitions in these areas require significant efforts to mitigate the tensions between what might be possible, what is practical, and what is affordable.

But we must always be oriented towards breaking through these barriers and mitigating the risks and constraining factors. The Blue Ridge Group believes that the best route forward to make progress in reforming care processes and accelerating appropriate HIT development and adoption and is for AHCS to pool these risks and to collaborate as much as possible to advance biomedical informatics, complexity science, our bioscience knowledge base and the development of better health care systems.

Figure 3.

Framework to Support Evolution to a System of Care

		Steps	Examples
	OUTCOMES	Value	Adherence to best practices, reduce errors, reduce prescriptions, reduce redundant/ over-lapping testing, increase compliance
	OUTCOMES	Change in Practice	Systems that support safety, patient centered care, disease management, evidence based decisions
INFRASTRUCTURE	NTERVENTIONS	Point of Information Systems	CPOE, eprescribing, closed loop medication administration, retail pharmacy, notification / escalation
INFRASTRUCTURE		Data Interchange	Patient index, lab results, medication dispensing record
INFRASTRUCTURE		Standards	Messaging, terminology, role-based authorization

Stead 2007

Fundamentally, we all share the commitment to build on the IOM Chasm report recommendations concerning the development and deployment of informatics and how it relates to the other four IOM competencies. We must find the best avenues to pursue new models that achieve the right combination of professional roles, care and related processes, and HIT to deliver reproducible quality and to drive needed system change and improvement. The Institute of Medicine has been a prime mover in identifying these comprehensive problems and the need for a comprehensive approach. Many other organizations and individuals have taken up this challenge. It is vital that AHCs do so as well in an organized and systematic manner. An effort of this magnitude requires a step by step approach. Figure 3 depicts the different layers of process and infrastructure required to move towards systems approaches to care. Each of the layers requires a different form of governance, skills and supporting technology. AHCs should engage in each layer, but most importantly at the upper layers where they can lead change in role and process.

An important step forward could be taken by the initiative of AHC leaders to establish common projects that can push this agenda forward. The first step is for those leaders to grasp that these changes are more about transformation of roles and processes, and the sciences of biomedical informatics and complexity, than about technology. They need to work with their informatics and information technology leaders to develop their strategy and road map. In this context, we believe that there are especially good opportunities for AHC's to work together on HIT. Informatics provides a potentially neutral and new ground to collaborate in ways we haven't seen before.

Stead, for instance, has proposed a consortium model for sharing and developing HIT skills sets and shared resources. This would involve using collaborative planning and technologies to nurture distributed departments of biomedical informatics where differing skill sets are concentrated at different institutions. This approach could accomplish something approaching a "distributive computing" model. New supercomputers, storage capacity, and increasingly sophisticated computational algorithms for analyzing data, make possible unprecedented advances in the harvesting and mining of data for the advancement of both individual and public health, building depth within teams and breadth across institutions. Currently, such capacities are spread among hundreds of more or less private databases and projects many of which are complementary and which could benefit from access to and participation in a larger network of investigators and resources. There is much potential to leverage a huge reservoir of expertise, skill and creativity, while sharing some of the risks, financial and otherwise, of finding the best pathways forward in health IT.

AMIA suggests that this effort must start by cataloguing current IT and informatics-related uses, activities, networks, and educational and research resources in each AHC. From this catalogue, it is conceivable that a consortium of AHCs and their leaders could create structure and operating agreements within which to maximize the utilization and learning and knowledge production within a distributed, but integrated network of cooperating facilities, projects, and individuals.

Sharing of information and the development of HIT capabilities would go a long way towards enabling AHCs to better configure new models and test them in the context of similar efforts across other AHCs and entities.

An effort like this will require that AHC leadership take unprecedented steps to enable collaboration both within and across institutions. And it requires that AHCs adopt an enhanced focus on informatics as both a science in itself and as a set of tools that can be catalysts for addressing cost risks, reducing complexity for patients and practitioners. And they must press to constantly improve clinical outcomes, enhance education and facilitate research, while accomplishing the related AHC missions. There are models for the process of taking stock of bioinformatics resources. For instance: The Integrated Academic (Advanced) Information Management Systems (IAIMS) as part of the now disbanded Integrated Advanced Information Management System (IAIMS) projects, fifteen institutions were funded to undertake such assessments by the National Library of Medicine. The Consortium is now folded under the AMIA umbrella and its annual workshops rotate among sites and are coordinated with the meetings of the AAMC Group on Information Resources where practical. These reports remain available online at: **http://www.iaimscons.org/reports/index.html**.

The Blue Ridge Group also believes that the consortia that have formed around the Clinical Translational Science Awards (CTSAs) could be terrific laboratories within which to develop of approaches to developing and distributing HIT across AHCs. These multi-institutional and multi-disciplinary consortia would appear to be prime candidates for the type of collaborative development, distribution and sharing of HIT capabilities. The Blue Ridge Group urges leadership within the CTSA consortia to undertake significant efforts to catalyze such HIT collaboration.

[Consortia examples:]

MedBiquitous

The non-profit initiative, MedBiquitous, provides a model for developing HIT and standards in a consortia model. MedBiquitous was founded by Johns Hopkins Medicine and leading professional medical societies and is "dedicated to advancing healthcare education through technology standards that promote professional competence, collaboration, and better patient care-" (**http://www.medbiq.org/index.html**). The consortium is creating a technology blueprint for professional healthcare education, based on XML and Web services standards. This blueprint is being designed to support learners and teachers by simplifying while enhancing educational and competence assessment. MedBiquitous is also designed to "provide a neutral forum for educators and industry alike to exchange ideas about innovative uses of Web technologies for healthcare education and communities of practice-" (Ibid).

Vanderbilt Biomedical Informatics Model

Vanderbilt's approach to bringing a critical mass of computer science together with its Department of Biomedical Informatics is an example of the distributed skill set model. Computer scientists that want to work close to a problem such as de-identification of electronic health records are recruited as full time members of the department. However their ties to CMU provide access to a critical mass of computer science talent that would never be practical at Vanderbilt. Similarly, relationships to Oak Ridge bring computational talent and resources. The relationships between Harvard and MIT and Pittsburgh and CMU do the same thing on a local scale.

University of Kansas School of Nursing

In exciting ways, nursing education is often taking the lead in education and training along these lines. At the University of Kansas School of Nursing, for instance, a jointly funded academic/business partnership between the School of Nursing and the Cerner Corporation called **S**imulated **E**-h**E**alth **D**elivery System or SEEDS, is pioneering new curricula and technologies for health professional education. Reportedly, this is the first live-production, clinical information system designed for care delivery to be used in a simulated way for teaching curriculum content to nursing students. This program is designed to provide teaching and learning tools to assist health professional students to develop competencies to harness the power of information technology, thus improving the quality, efficiency and effectiveness of healthcare (Connors, H. R. and Weaver, C. 2002; Connors et al 2002; Warren, et al 2002; Warren et al. 2004. And see: **http://www2.kumc.edu/son/abp.html**).

AAMC MedEdPORTAL

MedEdPORTAL is a new approach to online publication that offers peer review for teaching resources. Examples of MedEdPORTAL publications include tutorials, virtual patients, cases, lab manuals, assessment instruments, faculty development materials, etc. MedEdPORTAL is available free to the general public and covers the continuum of medical education (i.e. undergraduate, graduate, and continuing medical education). MedEdPORTAL contains descriptive information about published resources and indicates how these materials may be accessed or obtained.

MedEdPORTAL is a resource designed to help faculty publish and share educational resources. A long-standing priority of the AAMC Group on Educational Affairs, MedEdPORTAL is the only resource that focuses exclusively on the continuum of medical education and addresses the unique needs of medical educators. MedEdPORTAL was designed to promote collaboration and educational scholarship by facilitating the open exchange of peer-reviewed teaching resources.

What can be done in public policy?

Improving health in our nation requires not only the deployment of local electronic medical records systems, but a national health information infrastructure (NHII) that can provide connectivity, decision support, and knowledge management across national boundaries (Detmer 2003). This has been recommended by the National Committee on Vital and Health Statistics and the President's Information Technology Advisory Committee, among many other organizations and thought leaders. Overall leadership for this requires nation-wide buy-in and can be helped significantly by federal incentives or mandates. While we cannot count on large external revenue sources to appear, public research dollars can be targeted to areas of research and programmatic organization that promote the development of new models and technologies for research, training and care that we have discussed. Importantly, the public and private sectors need to increase their collaboration to build and implement the robust health care and information systems we need. AHCs collaboration in understanding and implementing model health IT systems could be pivotal in catalyzing the best approaches to HIT adoption. Many types of partnerships and initiatives are possible. Some are even experimenting with the potential for engaging children, schools, communities and the networked world at large in building systems and solutions through computer-based games, simulations, puzzles, challenges and other such innovative approaches. There is no doubt that there is much room for such creativity and invention in this effort.

Conclusion

One of the most daunting challenges in creating a value-driven health care system is to manage all of the complexities involved in organizing and providing care. While substantial progress towards this goal has occurred through the development of HIT systems, much work remains to be done. A sophisticated, powerful mobile, agile, and ubiquitous HIT infrastructure characterized by shared, feedback-loop learning and innovation, offers extraordinary opportunities for progress in all of the learning and solution-creating environments in health research, care and education envisioned in the IOM's Chasm Report. We can see that such capabilities are certainly possible. Leadership from our Nation's academic health centers is absolutely essential to turning this possibility into a reality.

Recommendations:

Recommendation #1. The Blue Ridge Group recommends that each academic health center inventory its "islands" of informatics (including both academic research oriented activities and operational). Understanding and organizing these and then making decisions to add new components that enhance value and improve internal processes and organization should be a major priority. This can simplify academic health center management and operations to lower costs, reduce complexity for patients and practitioners while constantly improving clinical outcomes.

Recommendation #2. In the clinical area, AHCs should design and implement IT solutions preceded by reengineering and redesign of clinical workflow and process, and not simply by imposing new HIT systems on existing processes.

- AHCs have the unique capacity to use populations available to them, including their own insured groups of employees, to develop and test new approaches, including real-time decision support for providers and patients, predictive information for patients, development of personal health records and treatment plans, "just in time just for me" data on outcomes and key processes. The Blue Ridge Group sees this is an opportunity for AHCs to capitalize on their unique organizations and missions to develop new models of HIT and practice solutions.

Recommendation #3. With personalized care now becoming a major focal point for HIT and care system redesign, the IOM should create a round table on personalized care. The round table should consist of experts from multiple disciplines, including organizational behavior, systems engineering, informatics, information system vendors, pharmaceutical leaders, and others. Among the topics would be personal health records and community based efforts focused on health promotion and prevention. A key objective should be to reduce complexity for patients and providers.

Recommendation #4. The Blue Ridge Group recommends that relevant HIT stakeholder organizations, like the American Medical Informatics Association (AMIA), the American Health Information Management Association (AHIMA), The National Association for Public Health Information Technology (NAPHIT), and other prominent organizations, along with the AHRQ, should work with academic health center and other relevant interests to catalyze progress in three areas:

- Standards for a model(s) to manage the IT infrastructure for the AHC missions in health education, research and clinical care, documenting experiences on implementation and lessons learned, including staffing, funding, and research opportunities
- Curriculum development for informatics education throughout professional education and practice, developing the informatics component of the IOM Chasm health care professional educational competencies.
- Other opportunities to build upon existing "pockets" of IT excellence that could become networked consortia.

Recommendation #5. The Academic Strategic Leadership Council (ASLC) or AMIA needs to specifically engage the National Center for Research Resources, and the CTSA Roadmap Steering Committee for Bioinformatics, and any other relevant bodies, to explore common initiatives relating to research and education in medical and health informatics.

Recommendation #6. The Blue Ridge Group recommends that the Association of Academic Health Centers (AAHC), the Association of American Medical Colleges (AAMC), The American Board of Internal Medicine (ABIM) and other relevant organizations and stakeholders consider the appropriate IT infrastructures for their programs and projects that examine the interface between curricular and practice requirements.

Recommendation #7. All academic and professional organizations and programs should treat information technology and informatics as core competencies throughout the continuum of education and in future workforce planning.

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