

Perspective: **Prospective Health Care and the Role of Academic Medicine: Lead, Follow, or Get Out of the Way**

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Abstract

The authors contend that the crisis facing the U.S. health care system is in large part a consequence of that system's disease-oriented, reactive, and sporadic approach to care, and they suggest that a prospective approach to health care, which emphasizes personalized medicine and strategic health planning, would be a more rational way to prevent disease and maximize health. During recent years, personalized, predictive, preventive, and participatory medicine—

that is, prospective care—has been receiving increasing attention as a solution to the U.S. health care crisis. Advocacy has been mainly from industry, government, large employers, and private insurers. However, academic medicine, as a whole, has not played a leading role in this movement. The authors believe that academic medicine has the opportunity and responsibility to play a far greater role in the conception and development of better models to

deliver health care. In doing so, it could lead the transformation of today's dysfunctional system of medical care to that of a prospective approach that emphasizes personalization, prediction, prevention, and patient participation. Absent contributing to improving how care is delivered, academic medicine's leadership in our nation's health will be bypassed.

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In a 2003 article, it was noted that the crisis facing the U.S. health care system was attributable, in part, to its ineffectiveness in preventing or minimizing chronic disease. This was a result of its reactive and sporadic approach to care and its emphasis on the treatment of disease events. As a consequence of this approach, chronic diseases and associated health care costs were increasing each year with no end in sight.

The Next Health Care Transformation

To address this, the development and validation of strategies to enable a shift toward personalized disease prevention

and early intervention were proposed, because the know-how and capabilities to be proactive already existed. It was noted that this shift to prospective care would be greatly enhanced by emerging capabilities to predict clinical risks and outcomes that would result from research in the new fields of genomics, proteomics, metabolomics, diagnostic imaging, bioinformatics, and systems biology.

Furthermore, it was suggested that the key to prospective health care—namely, personalized, predictive, preventive, and participatory medicine—would be strategic health planning based on personalized health plans.¹ Such plans would be comprised of personal health risk analyses along with long-term planning to minimize the likelihood of disease development or progression. Importantly, the model of health care delivery would need to shift from being sporadic and reactive to one capable of supporting health promotion, disease minimization, long-term approaches to care, and a far greater role for patient involvement. Of course, academic medicine would need to play a key role through all of its core missions by providing the knowledge and trained personnel to effect this transformation.

Much progress has been made in numerous areas related to the aforementioned concepts, which were

initially presented during the 2002 Chair's Address at the annual national meeting of the Association of American Medical Colleges (AAMC).² Ironically, however, most of the initiatives have occurred outside of academic medicine as a consequence of government-, consumer-, employer-, and insurer-led initiatives.

In this article, we review prospective health care initiatives which have evolved since 2002, and we suggest that academic medicine should play a far greater role if it is to facilitate the most favorable outcomes while retaining its rightful role as a leader in the improvement of our nation's health.

A Review of Prospective Health Care Initiatives

Shifting the practice of medicine to prospective care is possible given our current capabilities, but its refinement will necessitate progress on many fronts. These include research leading to the development of clinically useful personalized risk prediction, disease tracking, and therapeutic evaluation tools; the development of clinical practice models to deliver prospective care; and the education of the professional workforce needed to practice it. Of course, major changes in access to health care insurance and means of reimbursement for preventive care need

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to occur in order to rationalize health care. Academic medicine should play a dominant role in all these areas, given that its major responsibilities lie in the core missions of research, health care delivery, and education.

The research arena

Research is a key area where academic medicine has been a significant contributor in the move toward personalized medicine. During the past few years, research performed in governmental laboratories, by industry, and by academic institutions has begun to provide an increasingly rich infrastructure to identify the mechanisms involved in transitioning from health to disease and the biomarkers (biochemical features that can be utilized to predict disease development, progression, or response to therapy) which predict clinical events. This has enabled the means to more clearly define an individual's clinical risks and her or his likelihood to benefit from specific therapies. The completion of the Human Genome Project in 2003 and the International HapMap Project in 2005 (its goal was to identify common patterns of DNA sequence variation within the human genome so that genes associated with disease could be found),³ as well as advances in genomics, proteomics, metabolomics, bioinformatics, medical technologies, and systems biology, are improving researchers' and practitioners' capabilities to predict and track disease.

More specifically, contemporary biomedical research is identifying biomarkers that are likely to play an integral role in assessing individual disease susceptibility, disease progression, and response to therapy. For example, single-nucleotide polymorphisms (SNPs) in five chromosomal regions (three independent regions at 8q24, one region at 17q12, and one region at 17q24.3) were found to have strong cumulative associations with the development of prostate cancer, whereas each SNP alone was only moderately associated with the disease.⁴ Other biomarkers, including BRCA1 and BRCA2, identified in the 1990s, are considered two of the most important breast cancer susceptibility genes. Mutations to these genes yield a high risk for developing this disease.⁵ Other well-established genes where a mutation confers increased risk for breast cancer include TP53, ATM, and CHEK2.⁶

Another well-known biomarker is cytochrome P450 CYP2C9 and its association with the metabolism of warfarin. Individuals with an allelic variant of this cytochrome, either CYP2C9*2 or CYP2C9*3, are poor metabolizers of this drug and, therefore, require low dosages to minimize the risk of hemorrhaging.⁷

Major leaders in spurring research enabling predictive technologies have been the U.S. Department of Health and Human Services (HHS) and the National Institutes of Health (NIH). In 2007, HHS announced a new initiative called "Personalized Health Care," whose objective was to combine genomic research breakthroughs with advances in health information technology to enable gene-based medicine, where one's susceptibilities to diseases would be quantified as early as possible so that preventive countermeasures could be taken.⁸ An example of one of the many programs encompassed by the Personalized Health Care initiative is entitled "The Cancer Genome Atlas," which is a collaboration between the National Cancer Institute and the National Human Genome Research Institute. Researchers have been utilizing evolving technologies such as large-scale genome sequencing to better understand the molecular basis of cancer. Initial efforts have focused on cancers affecting the brain, lungs, and ovaries. The goal of this project is to improve capabilities for preventing, diagnosing, and treating cancer at a personalized level.⁹

A major endeavor begun in 2002 is the NIH Roadmap for Medical Research. One of the objectives of this research has been to better elucidate the interactions among the molecular events that underlie disease pathogenesis by focusing on emerging areas such as genomics, proteomics, and metabolomics. The Roadmap's Metabolomics Technology Development project is supporting the development of new tools to determine how cellular metabolites contribute to disease pathogenesis. This information could potentially provide a rich source of predictive biomarkers in the near future.¹⁰

The NIH has also collaborated with fellow HHS agencies such as the Food and Drug Administration and the Centers for Medicare and Medicaid

Services (CMS), as well as the Pharmaceutical Research and Manufacturers of America (PhRMA) and the Biotechnology Industry Organization, on initiatives such as The Biomarkers Consortium. The goal of this consortium is to identify and validate new biomarkers to help expedite the development and utilization of therapeutics and technologies for personalized prevention, early detection, and treatment of diseases.¹¹

A project in The Biomarkers Consortium under consideration by the National Institute of Diabetes and Digestive and Kidney Diseases is focused on the identification of biomarkers associated with prediabetes and type II diabetes and the creation of more reliable, less expensive, and faster predictive tests.¹²

Academic health centers (AHCs) such as the Lewis-Sigler Institute for Integrative Genomics at Princeton University, the Broad Institute of MIT and Harvard, and the Center for Genomic Medicine at the Duke Institute for Genome Sciences and Policy (IGSP) have been dedicated to identifying and validating predictive biomarkers. One project at the Broad Institute, entitled "Clinical Proteomic Technology Assessment for Cancer," is seeking to establish standards for protein biomarker assessment,¹³ and, at the IGSP, researchers recently outlined a genomic-based strategy for the personalized treatment of patients who have advanced-stage ovarian cancer.¹⁴

Another emerging field facilitating prospective medicine is systems biology. Systems biology seeks to understand how biological circuits involving genes and metabolic pathways interact to regulate biological activities in normal and pathological states. Understanding how such circuits function will play a critical role in improving capabilities to predict the evolution of various disease processes.¹⁵

Centers within academic institutions, such as the IGSP Center for Systems Biology at Duke University and the Center for Cancer Systems Biology (a collaboration between the Dana-Farber Cancer Institute and Harvard Medical School), have dedicated vast resources to personalized medicine. Researchers from the Center for Cancer Systems Biology detailed an approach to identify genes associated with increased

breast cancer risk. By using this strategy, they determined that hyaluronan-mediated motility receptor was a potential breast cancer susceptibility gene.¹⁶

Although many of the recent research initiatives have been genomic based, genomic advances alone will not likely be sufficient to enable personalized medicine. Rather, multiple rapidly evolving predictive technologies such as proteomics and metabolomics will complement and enhance clinical knowledge and capabilities to allow better predictive approaches. For example, studies on risk-predictive modeling for breast cancer recurrence have shown that the predictive accuracy of a combined clinical and genomic model is higher than a model using just one type of data.¹⁷ Furthermore, a risk predictive model for severe adverse outcomes from cancer chemotherapy was developed using only clinical and laboratory data.¹⁸

The clinical arena

Application of risk assessment capabilities. Personalized health planning requires the evaluation of an individual's risk for developing diseases and the formulation of predictions concerning outcome. In the past, assessments for baseline clinical risk were based on the use of clinical, demographic, family history, and laboratory risk factors. Although these types of data have provided insight into the likelihood of an individual developing a condition or event, they have generally been limited in terms of being able to accurately predict the timing of a disease event and, thus, have provided general guidance only. Current research is enabling the identification and clinical use of biomarkers, which more accurately predict disease events and therapeutic outcomes and can be used in combination with traditional risk factors.

The ability to use biomarkers to predict clinical events and to guide therapy is nascent, but a number of initiatives demonstrate the emergence of this field. Many of these have focused on the development of risk assessment tools to determine baseline clinical risk, predict clinical events, and predict response to therapy. A host of companies have developed that specialize in areas such as molecular diagnostics, pharmacogenomics, and predictive

modeling.^{19–23} For instance, a program called “Know Your Number” is recently available that encompasses a set of risk models for predicting and tracking conditions such as type 2 diabetes, coronary heart disease, breast cancer, colon cancer, and others.²⁴ These models generate individualized risk assessments for the specific chronic conditions and determine how much of the risk is modifiable so that tailored countermeasures can be developed.

Other promising developments are risk assessment tools focused on prediction and prevention for specific specialty points of care. For example, a validated diagnostic assay has been developed that analyzes the risk of breast cancer recurrence in women with newly diagnosed, early-stage breast cancer. This test assesses the expression of 21 genes and generates a “recurrence score” based on this analysis.²⁵ This information can then be used to help determine the best treatment strategy for an individual. Similarly, molecular expression testing noninvasively assesses the risk of acute cellular rejection among heart transplant recipients.²⁶ This test measures the expression level of 20 genes in mononuclear blood cells and translates this information into a risk score for graft rejection.

Whereas the aforementioned risk assessment tools are directed toward providers, other companies have developed personalized risk assessment tools for sale to consumers.^{27,28} An assessment is available that analyzes 250 serum proteins to provide early diagnosis of clinically unapparent diseases.²⁹ In addition, consumers receive medical history interviews and follow-up doctor consultations. Likewise, consumers may pursue individualized health and nutrition recommendations which are based in part on genomic analysis.³⁰ Still other options are available from companies that perform genomic analysis to identify known risk-associated variants. Consumers are offered predictive information and options for updated genomic analysis as new susceptibility factors are identified. The direct-to-consumer marketing of diagnostics and predictive tools is a relative new phenomenon, and its value and means of regulation have yet to be determined.

The development of clinically validated predictive tools by industry requires close collaboration between industry and AHCs because AHCs play a critical role in the translation of research discoveries into practical clinical applications. Initiatives such as the NIH's Clinical and Translational Science Awards program have begun to provide much-needed support for AHCs to become leaders in translational research. Since 2006, 38 AHCs have received funding to develop and improve capabilities to create practical applications of basic research discoveries.³¹ We anticipate that one outcome of this research will be to enhance the knowledge base needed to deliver personalized, predictive, and preventive care.

Although the development of risk assessment tools utilizing genomic and other biomarkers is an emerging field, tools for disease prediction based on epidemiological and clinical data are not new. For example, the Framingham Coronary Heart Disease Model and the Gail model for breast cancer risk assessment provide valuable general information about risk, but they have not been widely used for patient care by practitioners.^{32,33} To take full advantage of current and emerging evidence-based risk assessment tools, practitioners need to incorporate such tools seamlessly into routine clinical practice and patient care. One way would be to integrate formalized risk assessments into the patient evaluation with support from a personalized and strategic health record.

Personalized health records. A major focus of prospective health care is personalized strategic health planning or, more specifically, the development of personalized health plans. Key components of such a plan would include an individualized health risk assessment, current health status, disease burden quantification, pathogenesis tracking, clinical event predictions, and health maintenance and therapeutic plans. Given that today's medical record is disease oriented and makes no provisions for strategic health planning, a new form of the medical record will need to be developed to support personalized health planning.³⁴

During the past few years, many projects have focused on repositioning the current medical record to enable personalized, predictive, preventive, and participatory

approaches to health care. The CMS has played a leadership role in the development of patient-based personal health records as an adjunct to the provider-based electronic medical record. It has collaborated with four health plans (Kaiser Permanente, Humana, Health Insurance Plan USA, and University of Pittsburgh Medical Center) on a pilot project to test the use of personal health records among Medicare beneficiaries. This initiative has been an attempt to encourage members to take charge of their health management by using Web-based tools to track their health care services and to better communicate with their health care providers.³⁵

Whereas the CMS's health record initiative has focused on the personalized and participatory facets of patient care, other medical record initiatives have integrated predictive and preventive aspects. WebMD has developed the WebMD Personal Health Manager, a set of online health management tools for employers and their beneficiaries. Not only does this include an online personal health record where individuals can store, monitor, and update their own health information, but it also encompasses a health risk assessment tool called "HealthQuotient," which assesses the individual's current health status, quantifies his or her risk levels, then suggests interventions for improved health and behavior modification.³⁶

Some large companies (such as Verizon and Dell) have realized the importance of health promotion and disease prevention among their own workforce and have collaborated with industry leaders such as WebMD to develop personal health records for their employees.³⁷ These records provide tools which enable individuals to assess their health risks and to set health goals for preventing or minimizing these risks, in addition to managing ongoing chronic conditions. Other companies are following this example: Wal-Mart, Intel, Applied Materials, BP America, and Pitney Bowes have donated at least \$1 million each to develop a personal health record known as "Dossia."³⁸ This record not only enables individuals to maintain their own lifelong record by entering data themselves; it also aggregates electronic medical data about the individuals from various sources. The goal of this record is to encourage employees to actively

manage their own health and to help companies reduce unnecessary costs related to treating disease instead of promoting health.

Insurers have also recently recognized the importance of increasing patient engagement and the value of using personal health records. A report by America's Health Insurance Plans detailed how some major insurers (such as United HealthCare, Kaiser Permanente, Blue Cross Blue Shield, and Cigna) have become proactive in the development of innovative models of prospective health care such as personal health records.³⁹ Aetna has launched a Web-based personal health record based both on patient-entered and on claims-driven data from various sources.⁴⁰ It was developed so that members could collaborate with their doctors in making the most evidence-based and individualized health care decisions. This dynamic record continuously analyzes medical data as it is added to identify opportunities for improved care and to notify patients and doctors about potential emergency situations.

There has also been much speculation about future initiatives by companies such as Google. The Google Health initiative, which recently debuted, will be an online platform integrating components such as personal health records as well as links to other personal health services.⁴¹ One of Google's rivals, Microsoft, already has its own major health initiative. In 2007, Microsoft launched HealthVault, where members control the collection, storage, and sharing of their medical data through their own Web-based accounts.⁴² Not only can members create personal health records for themselves as well as for family members, but they can also share personal medical information with health management Web sites. Revolution Health also provides its members with information and capabilities, such as tools to assess and track their health as well as to develop their own health portfolio, to manage their health.⁴³

Personal health record initiatives have also been underway at AHCs such as Emory Health Care, Thomas Jefferson University Hospital, and Vanderbilt University Medical Center. Emory Health Care offers a Web-based tool called "Your Personal Health Record" which

enables patients and their families to enter personal medical information themselves and to be involved in managing their own medical care.⁴⁴ The record also offers features for patients with specific conditions necessitating continuous monitoring, such as diabetes, congestive heart failure, asthma, and sleep disorders. For example, patients with asthma are able to input their daily peak flow meter readings so that they can track them over time.

Vanderbilt University Medical Center is developing a personal health record system called "My-Medi-Health" to enable children with cystic fibrosis to take a more proactive part in managing their medications.⁴⁵ Such a system should also reduce the likelihood of children getting incorrect dosages and help providers better understand why and how their patients are experiencing therapeutic side effects.

Hopefully, more AHCs will follow suit, especially given that the U.S. Secretary of Health and Human Services, the administrator of the CMS, and the National Coordinator for Health Information Technology have all deemed personal health records a major priority.⁴⁶

Clinical delivery models. The development of clinical delivery models which support prospective care is critical to its implementation and adoption. Progress in this area has been slow, and comprehensive models have yet to be developed. Current reimbursement policy and health insurance issues make the development of prospective care models difficult to implement, given that government funds for AHCs are not readily available for prevention. Nonetheless, one company has created a program enabling components of prospective medicine based on what has sometimes been called "concierge" medicine (also known as "boutique" medicine). This approach is focused on providing its members, who each pay \$1,500 above health insurance, with benefits not generally available through usual health plans. Patients who join concierge medicine groups pay annual fees for medical services such as getting same-day and unrushed appointments as well as having constant access to their providers. Importantly, this approach provides every member with her or his personalized health Web site.⁴⁷ This tool

enables each participant to develop an individualized health risk assessment based on her or his family history, lifestyle habits, and personal history. Participants can also develop a personalized health plan which they monitor themselves.

Other companies are developing programs that enable prospective disease management approaches.⁴⁸ These programs focus on patients with specific chronic conditions and enable them to better manage their health care by integrating evidence-based guidelines, multidisciplinary teams of health care providers, patient self-management education programs, and outcomes measurement and tracking. Such programs are proving to be successful in improving self-management and decreasing the use of unnecessary health care services.

Clinical care is a core mission of academic medicine, and the academy has been a constant source of innovation in specialty care. However, academic medicine has not yet become engaged in the systematic exploration of more rational models than those in existence for strategic or long-term approaches to general clinical care. Only a handful of AHCs have developed comprehensive, albeit nascent, programs enabling prospective approaches to patient care.

In 2003, for instance, Duke University initiated Duke Prospective Health (DPH), a personalized care, disease management, and wellness program for its employees. The program, which Duke University physicians helped develop and manage, sought to prevent or detect chronic conditions at its earliest stages by having patients develop and use a Personal Health Plan.⁴⁹

The program has three main components for its members. First is the Health Risk Assessment, which analyzes lifestyle and habits to help patients and their providers identify current and potential health issues necessitating attention. Patients use the results of their Health Risk Assessment to develop long-term strategic goals. Furthermore, patients are able to track certain metrics such as weight, blood pressure, back pain, and cholesterol. Second is Care Management, where an assigned care manager serves as the patient's point of contact and works with the patient to help formulate a plan

which meets his or her health needs. This includes assistance with developing a Personal Health Plan, determining optimal ways to achieve the goals outlined in the plan, and monitoring progress toward accomplishing the goals. Third is Coaching, where patients work with a health coach in a group setting. They participate in group activities to develop new skills which support healthy lifestyle changes and help them meet their goals. Although the program is relatively new, preliminary analysis conducted by a third party found that the DPH program was already providing benefits in terms of cost and service use.⁵⁰

A few other AHCs have established similar programs. Ohio State University created an employee health program called "Your Plan for Health," which provides tools and programs to enable preventive and personalized health management. Similar to the DPH program's Health Risk Assessment, Health Care Coach, and Care Management components, Your Plan for Health offers a Personal Health Assessment, Health Coach, and Care Coordination.⁵¹ Although these various models of clinical delivery are still new, they are emblematic of a broad-based move toward prospective medicine.

Advocacy groups. Advocacy groups supporting prospective health approaches have begun to emerge. Organizations such as the Personalized Medicine Coalition (PMC) (Washington, DC), the Center for Accelerating Medical Solutions (Washington, DC), and the Center for Medicine in the Public Interest (New York, NY) have been promoting the understanding and implementation of prospective medicine approaches and products by bringing together key health care constituents to discuss and analyze issues related to them (e.g., pharmacogenomics, genetic data discrimination, reimbursement, etc.), with the ultimate goal of influencing health policy to enable prospective health care.⁵²

Recently published findings based on the PMC's Personalized Medicine Landscape Analysis and Strategic Plan project discuss the current level of knowledge and involvement in personalized medicine issues among a wide range of health care constituents and analyze the economic, organizational, and scientific barriers to integrating such an

approach. The study also includes policy recommendations based on interviews with a broad range of health care constituents.⁵³ Although initiated by the PMC, this project was a collaborative effort among health care stakeholders such as the Centers for Disease Control and Prevention, Duke University, IBM, PhRMA, and Pfizer. Other AHCs, including The George Washington University Medical Center, Mayo Clinic, and the University of Pennsylvania Health System, have demonstrated support for prospective medicine by becoming members of PMC.⁵⁴

In addition to collaborative initiatives such as these, advocacy groups have been regularly sponsoring educational seminars and conferences on the importance of prospective health care and, in the case of the PMC, have been creating task forces on various health policy issues related to prospective medicine. Such initiatives are beginning to affect the health policy arena. For example, in addition to HHS Secretary Michael Leavitt introducing the Personalized Health Care initiative last year, in August 2006 Senator Barack Obama introduced the Genomics and Personalized Medicine Act of 2006. This bill sought to take advantage of evolving genomic research by creating incentives to speed up industry innovations, by removing regulatory barriers, and by providing more funding for research.⁵⁵ Such major health policy initiatives are proof that key opinion leaders are beginning to pay more attention to the importance of prospective health care and are engaging in discussions and initiatives to address it.

Medical education and clinical training

An area vital to the development and sustainability of prospective health care is medical education and clinical training. As a 2003 report by the Blue Ridge Academic Health Group⁵⁶ noted, "One arguably deleterious consequence of this focus on disease treatment, however, was the relative neglect of health promotion and disease prevention." The Association for Prevention Teaching and Research⁵⁷ has been promoting the integration of prospective medicine concepts for many years through initiatives such as its Inventory of Knowledge and Skills Relating to Disease Prevention and Health Promotion prospectus. It includes an outline of core concepts to be taught,

such as “risk status as an estimate of the state of an individual’s risk determined from data on genetic inheritance, environmental exposures, health habits” and “use and interpretation of the health risk appraisal.”

Unlike areas where constituents other than academic medicine can lead prospective health care initiatives, medical education requires that academic medicine take the first step and lead in order for fundamental changes in health care delivery to occur. Some medical schools have begun introducing topics such as risk assessment, health promotion, disease prevention, and wellness into their curricula. For example, students at Albert Einstein College of Medicine take a required course, Principles of Preventive Medicine and Clinical Research, during their first year, and second-year medical students at the University of Mississippi School of Medicine take Preventive Medicine and Public Health, also a required course.⁵⁸ Duke University School of Medicine prioritized prospective health care as a learning objective when it revamped its curriculum in 2003. Being able to “practice personalized health planning for long-range goals” was one of its major goals. Although this has not yet happened on a schoolwide scale, fourth-year electives such as Integrative Medicine and Prospective Health and Health Promotion and Disease Prevention are available.⁵⁹

We believe that the fundamental concepts underlying the theory and practice of prospective medicine should become central parts of medical education. For the basic sciences, this would include teaching concepts of disease evolution from health and the role of predictive biomarkers in this process. Clinical education would include concepts of a medical evaluation comprising health risk prediction, current health status, pathogenesis tracking, pharmacogenetics, health planning, patient motivation, and disease management. To our knowledge, this has not yet occurred to any significant degree among U.S. medical schools or residency training programs.

Barriers to Change

Health care has become one of the largest industries in the United States and has

become increasingly influenced by market forces and vested interests. For AHCs, this has meant facing regulatory and financial pressures from constituents such as the government and private insurers. To remain financially viable, the academic medical enterprise has needed to become more clinically productive and efficient while providing the vast proportion of uncompensated care and supporting the threefold academic missions. This environment has forced many AHCs to become competitive with private industry by focusing on delivery services with high financial margins to be able to support shortfalls elsewhere.

The reimbursement system has been a major barrier to enabling prospective health care delivery, especially for AHCs, given that funding has traditionally rewarded medical interventions for treating disease instead of preventive care. For example, a study at Duke University showed the value of a proactive management program for congestive heart failure in improving outcomes and greatly reducing costs. Nonetheless, the health system lost money because the program resulted in decreased hospitalizations (created margins) and increased ambulatory visits (created deficits).⁶⁰ This illustrates how the current reimbursement system prevents academic health centers from focusing on better delivery models which, ironically, may reduce margins. Indeed, a major reason that DPH could be initiated at Duke is that the covered individuals, university employees and their families, are largely self-insured by Duke, thus aligning incentives to prevent as well as treat disease.

Whereas external influences have contributed to academic medicine’s lackluster role in enabling the move toward prospective health care, internal factors have also played a part. A significant condition was best stated by Dr. Jordan Cohen during his AAMC President’s Address in 2004 when he quoted a friend: “We in academic medicine love progress, but we don’t like change!”⁶¹ Although past successes in research, patient care, and medical education may have contributed to such reluctance to change, academic medicine’s fragmented governance and organization have also been significant impediments to change and adaptation. Deans, department chairs, and hospital

administrators have traditionally operated independently of one another to evolve their own departments, and they have displayed little ability or desire to affect the system as a whole. Consequently, this fragmented approach has contributed to AHCs struggling to survive, let alone innovate, in a rapidly changing health care environment.

Concerns About Prospective Health Care

As the move toward prospective medicine continues, it is important to understand and address potential drawbacks to this evolving health care approach. One concern is that prospective health care will be redundant and, thus, competitive with public health initiatives in its approaches to preventive medicine. Clearly, public health and personalized approaches should be synergistic and will compel the close engagement of public health and medicine.⁶² Furthermore, it has been shown that medical care approached at an individualized level increases the likelihood that treatment plans will be followed.⁶³

Another concern has been the fear that risk-predictive tools will replace the physician’s clinical judgment and diminish personal patient–physician interactions. Tools to enable prospective care are meant to serve as adjuncts to and not replacements for the physician’s skills, experiences, and personal interactions with patients. Such tools should facilitate, not hinder, increased collaboration between provider and patient in health care management.

With the rapid evolution of fields such as genomics, patients have become increasingly concerned about medical privacy, genetic discrimination by insurers and employers, and related issues. Indeed, there has been evidence that even healthy persons with a genetic susceptibility for a condition have faced discrimination by insurance companies and that those with genetic diseases have had a difficult time getting health insurance.^{64,65} This is an evolving area which will necessitate careful policy development. These issues, as well as others such as assessing the reliability of data entered by patients or the accuracy of risk assessment tools, are legitimate concerns which must be continuously monitored and addressed by the appropriate constituents.

The development of prospective care approaches thus far have largely occurred outside the mainstream of health care delivery. As already noted, current insurance and reimbursement mechanisms restrict the development of creating models to avoid or minimize disease. It is our view that the appearance of prospective care programs outside current insured programs signifies the pent-up desire by the public for such programs to be created and provides further evidence that the current system, which is expensive yet not universal, needs to be substantially revised.

Leading the Prospective Health Care Transformation

The move toward prospective medicine is gaining momentum, albeit largely without the leadership of academic medicine. We believe that this is not good for health care or for academic medicine. We suggest that academia must rethink its role in leading rational health care reform. Academic health centers were bastions of change a century ago when they introduced science into the practice of medicine. Their relevance as leaders of health care is now threatened unless they again seize the opportunity to be relevant to our nation's health needs for reform and redesign of how care is delivered. Change could begin with cohesive leadership from medical schools and teaching hospitals as well as the AAMC. Academic medicine must not lose sight of its core missions of innovating in research, patient care, and medical education. These missions must, however, be forward looking and anticipate how medicine can and should be practiced. Importantly, academic leaders must recognize that these initiatives must provide the infrastructure for more rational models of health care delivery than are currently in practice. We suggest a concerted effort on the part of academic medicine to accept its role in creating more relevant models of health care delivery designed to promote health as well as treat disease.

One approach to enabling the creation of such models by AHCs could be structured as an initiative of the Agency for Health Care Research and Quality's Effective Health Care Program. To support the program's goal of researching which drugs and other medical interventions work optimally for specific

health conditions, a consortium of 13 new research centers was established. The reports generated by the research conducted at these centers provide direction for the funding of future projects, for which these same centers then compete.⁶⁶ An even bolder approach would be for the government to enable the CMS to fund multiple large pilot programs in prospective care so that AHCs and others could develop practical, comprehensive models. Those that work could replace the currently, expensive, yet less effective, approaches.

Finally, AHCs could begin by working individually and collaboratively with the AAMC and with state and federal government to facilitate efforts leading toward health care reform that would enable prospective health care.

The Bottom Line for Academic Medicine

It is becoming increasingly recognized that today's disease-oriented approach to medical care is dysfunctional and needs to shift toward personalized, predictive, preventive, and participatory care—that is, prospective medicine. During the past few years, numerous nonacademic medicine constituents have taken the lead in developing and validating new models of prospective medicine. The initiative taken outside mainstream academic medicine indicates the interest on the part of government, industry, large employers, private insurers, and the public to move health care in this direction. Although academic medicine has made significant contributions to research in personalized medicine, its overall efforts have paled in comparison with what is possible and with the work of others who have recognized the need to reform the health care delivery system.

Academic institutions have made little progress in developing clinical care models and medical education to enable prospective care. Given academic medicine's central role in research, patient care, and medical education, it has the responsibility to create better models of health care and to train the workforce needed to support it. Absent such efforts, its leadership role in improving the nation's health will be diminished and assumed by others. Therefore, as those involved with academic medicine evaluate their role in

the move toward prospective medicine, they may want to heed the adage, "Lead, follow, or get out of the way."⁶⁷

References

- 1 Snyderman R, Williams RS. Prospective medicine: The next health care transformation. *Acad Med.* 2003;78:1079–1084.
- 2 Association of American Medical Colleges. AAMC chair's address 2002: Prospective medicine: The next health care transformation [press release]. November 10, 2002. Available at: (<http://www.aamc.org/newsroom/pressrel/2002/021111.htm>). Accessed April 3, 2008.
- 3 Thorisson GA, Smith AV, Krishnan L, Stein LD. The International HapMap project Web site. *Genome Res.* 2005;15:1592–1593.
- 4 Zheng SL, Sun J, Wiklund F, et al. Cumulative association of five genetic variants with prostate cancer. *N Engl J Med.* 2008;358:1–10.
- 5 Antoniou AC, Easton DF. Models of genetic susceptibility to breast cancer. *Oncogene.* 2006;25:5898–5905.
- 6 Begg CB, Haile RW, Bork A, et al. Variation of breast cancer risk among BRCA1/2 carriers. *JAMA.* 2008;299:194–201.
- 7 Aithal GP, Day CP, Kesteven P, Daly AK. Association of polymorphisms in the cytochrome P450 CYP2C9 with warfarin dose requirement and risk of bleeding complications. *Lancet.* 1999;353:717–719.
- 8 U.S. Department of Health and Human Services. Personalized Health Care. Available at: (<http://www.hhs.gov/myhealthcare>). Accessed April 3, 2008.
- 9 National Cancer Institute and National Human Genome Research Institute. The Cancer Genome Atlas. Available at: (<http://cancergenome.nih.gov>). Accessed April 17, 2008.
- 10 Zerhouni EA. The NIH Roadmap. *Science.* 2003;302:63–72.
- 11 National Institutes of Health. The Biomarkers Consortium. Available at: (<http://www.biomarkersconsortium.org>). Accessed April 3, 2008.
- 12 Zerhouni EA, Sanders CA, von Eschenbach AC. The Biomarkers Consortium: Public and private sectors working in partnership to improve the public health. *Oncologist.* 2007;12:250–252.
- 13 Broad Institute. Clinical Proteomic Technology Assessment for Cancer (CPTAC) Program. Available at: (<http://www.broad.mit.edu/proteomics/CPTAC/index.html>). Accessed April 3, 2008.
- 14 Dressman HK, Berchuck A, Chan G, et al. An integrated genomic-based approach to individualized treatment of patients with advanced-stage ovarian cancer. *J Clin Oncol.* 2007;25:517–525.
- 15 Hood L, Heath JR, Phelps ME, Lin B. Systems biology and new technologies enable predictive and preventative medicine. *Science.* 2004;306:640–643.
- 16 Pujana MA, Han J-DJ, Starita LM, et al. Network modeling links breast cancer susceptibility and centrosome dysfunction. *Nat Genet.* 2007;39:1338–1349.
- 17 Pittman J, Huang E, Dressman H, et al. Integrated modeling of clinical and gene expression information for personalized

- prediction of disease outcomes. *Proc Natl Acad Sci USA*. 2004;101:8431–8436.
- 18 Lyman GH, Kuderer NM, Crawford J, et al. Prospective validation of a risk model for first cycle neutropenic complications in patients receiving cancer chemotherapy. 2006 ASCO Annual Meeting Proceedings Part 1. *J Clin Oncol*. June 24, 2006;(18 suppl):8561.
 - 19 CardioDx, Inc. Web site. Available at: (<http://www.cardiodx.com>). Accessed April 14, 2008.
 - 20 Genomic Health, Inc. Web site. Available at: (<http://www.genomichealth.com>). Accessed April 14, 2008.
 - 21 Millennium Pharmaceuticals, Inc. Web site. Available at: (<http://www.mlnm.com>). Accessed April 14, 2008.
 - 22 SAS Institute Inc. Web site. Available at: (<http://www.sas.com>). Accessed April 14, 2008.
 - 23 Proventys Inc. Web site. Available at: (<http://proventys.com>). Accessed April 14, 2008.
 - 24 BioSignia Inc. Web site. Available at: (<http://www.biosignia.com>). Accessed July 5, 2007.
 - 25 Dobbe E, Gurney K, Kiekow S, Lafferty JS, Kolesar JM. Gene-expression assays: New tools to individualize treatment of early stage breast cancer. *Am J Health Syst Pharm*. 2008; 65:23–28.
 - 26 Xdx products and services. Available at: (<http://www.xdx.com/products/ps.htm>). Accessed April 3, 2008.
 - 27 Navigenics Inc. Web site. Available at: (<http://www.navigenics.com>). Accessed April 14, 2008.
 - 28 23andMe, Inc. Web site. Available at: (<https://www.23andme.com>). Accessed April 14, 2008.
 - 29 Biophysical health assessments. Available at: (<http://www.biophysicalcorp.com/assessments/biophysical250.aspx>). Accessed April 3, 2008.
 - 30 About Sciona. Available at: (<http://www.sciona.com>). Accessed April 3, 2008.
 - 31 National Center for Research Resources. CTSA science awards. Available at: (http://www.ncrr.nih.gov/clinical_research_resources/clinical_and_translational_science_awards/). Accessed June 5, 2008.
 - 32 Campbell CY, Nasir K, Blumenthal RS. Metabolic syndrome, subclinical coronary atherosclerosis, and cardiovascular risk. *Am Heart Hosp J*. 2005;3:105–110.
 - 33 Euhus DM. Understanding mathematical models for breast cancer risk assessment and counseling. *Breast J*. 2001;7:223–232.
 - 34 Yoediono Z, Snyderman R. Proposal for a new health record to support personalized, predictive, preventative and participatory medicine. *Personalized Med*. 2008;5:47–54.
 - 35 Centers for Medicare and Medicaid Services. Personal Health Records overview. Available at: (<http://www.cms.hhs.gov/PerHealthRecords>). Accessed April 3, 2008.
 - 36 WebMD Health Manager. Available at: (<http://www.webmd.com/health-manager>). Accessed April 3, 2008.
 - 37 PR Newswire. Verizon CEO announces implementation of new online personal health records program for company employees. Available at: (<http://sev.pnnewswire.com/telecommunications/20070509/NYU10309052007-1.html>). Accessed June 5, 2008.
 - 38 eWEEK. Large employers to provide online personal health records. Available at: (<http://www.eweek.com/article2/0,1895,2069937,00.asp>). Accessed April 3, 2008.
 - 39 America's Health Insurance Plans. Innovations in Health Information Technology. Available at: (http://www.ahipresearch.org/pdfs/AHIP_InvHealthIT_05.pdf). Accessed April 3, 2008.
 - 40 Aetna. Aetna introduces powerful, interactive personal record. Available at: (http://www.aetna.com/news/2006/pr_20061003.htm). Accessed April 3, 2008.
 - 41 Google Health. About Google Health. Available at: (<https://www.google.com/health/html/about/index.html>). Accessed June 5, 2008.
 - 42 Microsoft HealthVault. Available at: (<http://www.healthvault.com>). Accessed April 3, 2008.
 - 43 Revolution Health Web site. Available at: (<http://www.revolutionhealth.com>). Accessed April 14, 2008.
 - 44 Emory Healthcare. Your Personal Health Record. Available at: (http://www.emoryhealthcare.org/patient_guide/health_record_intro.html). Accessed April 3, 2008.
 - 45 Vanderbilt University Medical Center. My-Medi-Health. Available at: (<http://www.mc.vanderbilt.edu/root/vumc.php?site=mymedihealth>). Accessed April 3, 2008.
 - 46 Tang PC, Ash JS, Bates DW, Overhage JM, Sands DZ. Personal health records: Definitions, benefits, and strategies for overcoming barriers to adoption. *J Am Med Inform Assoc*. 2006;13:121–126.
 - 47 myMDVIP Personal Web site. Available at: (<http://mdvip.com/NewCorpWebsite/VeryImportantPatients/PersonalHealthWebsiteDemonstration.aspx>). Accessed April 3, 2008.
 - 48 Pope JE, Hudson LR, Orr PM. Case study of American Healthways' diabetes disease management program. *Health Care Financ Rev*. 2005;27:47–58.
 - 49 Duke University Health System. Duke Prospective Health. Available at: (<http://www.dukeprospectivehealth.org>). Accessed April 3, 2008.
 - 50 Michalka E, Grantham P. Cure for health? Results show Duke Prospective Health pays off. *INSIDE Duke Medicine*. 2007;16. Available at: (<http://www.inside.duke.edu/article.php?IssueID=177&ParentID=17019>). Accessed April 3, 2008.
 - 51 Your Plan for Health. Available at: (<http://www.yourplanforhealth.com/plan.html>). Accessed April 3, 2008.
 - 52 Personalized Medicine Coalition Web site. Available at: (<http://www.personalizedmedicinecoalition.org>). Accessed April 3, 2008.
 - 53 Deverka PA, Doksum T, Carlson RJ. Integrating molecular medicine into the US health-care system: Opportunities, barriers, and policy challenges. *Clin Pharmacol Ther*. 2007;82:427–434.
 - 54 Personalized Medicine Coalition. PMC members. Available at: (http://www.personalizedmedicinecoalition.org/about/pmc_members.php). Accessed April 3, 2008.
 - 55 Obama introduces bill to help tap power of genomics to find cures. Available at: (http://obama.senate.gov/press/060809-obama_introduce_9). Accessed April 3, 2008.
 - 56 The Blue Ridge Academic Health Group. Reforming Medical Education: Urgent Priority for the Academic Health Center in the New Century. Available at: (http://www.whsc.emory.edu/blueridge/_pdf/blue_ridge_report_7_2003may.pdf). Accessed April 3, 2008.
 - 57 Association for Prevention Teaching and Research. Inventory of Knowledge and Skills Relating to Disease Prevention and Health Promotion. Available at: (<http://www.aptrweb.org/resources/pdfs/Inventory.pdf>). Accessed July 31, 2007.
 - 58 Association of American Medical Colleges. Curriculum Directory. Available at: (<http://www.services.aamc.org/currdir/section4/start.cfm>). Accessed July 31, 2007.
 - 59 Duke University School of Medicine, Medical school goals and objectives. Available at: (<http://medschool.duke.edu/wysiwyg/downloads/GoalsObjectives.pdf>). Accessed June 5, 2008.
 - 60 Herzlinger RE. Where are the innovators in health care? *Wall Street Journal*. July 19, 2007:A15.
 - 61 Association of American Medical Colleges. AAMC president's address 2004: "Promising change" [press release]. November 7, 2004. Available at: (<http://www.aamc.org/newsroom/pressrel/2004/041107.htm>). Accessed January 20, 2008.
 - 62 McGinnis JM. Can public health and medicine partner in the public interest? *Health Aff (Millwood)*. 2006;25:1044–1052.
 - 63 Wagner ED, Bennett SM, Austin BT, Greene SM, Schaefer JK, Vonkorf M. Finding common ground: Patient-centeredness and evidence-based chronic illness care. *J Altern Complement Med*. 2005;11(suppl 1):S7–S15.
 - 64 Kass NE, Medley AM, Natowicz MR, et al. Access to health insurance: Experiences and attitudes of those with genetic versus non-genetic medical condition. *Am J Med Genet A*. 2007;143:707–717.
 - 65 Plantinga L, Natowicz MR, Kass NE, Hull SC, Gostin LO, Faden RR. Disclosure, confidentiality, and families: Experiences and attitudes of those with genetic versus nongenetic medical conditions. *Am J Med Genet C Semin Med Genet*. 2003;119:51–59.
 - 66 Agency for Healthcare Research and Quality. AHRQ launches new "effective health care program" to compare medical treatments and help put proven treatments into practice. Available at: (<http://www.ahrq.gov/news/press/pr2005/effectivepr.htm>). Accessed April 3, 2008.
 - 67 Watkins RD. *An Encyclopedia of Compelling Quotations*. Peabody, Mass: Hendrickson Publishers; 2001.