

ALSO BY LAWRENCE L. WEED

Medical Records, Medical Education and Patient Care

Your Health Care and How To Manage It

Knowledge Coupling: New Premises and New Tools for Medical Care and Education

MEDICINE IN DENIAL

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Lawrence L. Weed and Lincoln Weed

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Overview

Essential to health care reform are two elements: standards of care for managing clinical information (analogous to accounting standards for managing financial information), and electronic tools designed to implement those standards. Both elements are external to the physician's mind. Although in large part already developed, these elements are virtually absent from health care. Without these elements, the physician continues to be relied upon as a repository of knowledge and a vehicle for information processing. The resulting disorder blocks health information technology from realizing its enormous potential, and deprives health care reform of an essential foundation. In contrast, standards and tools designed to integrate detailed patient data with comprehensive medical knowledge make it possible to define the data and knowledge taken into account for decision making. Similarly, standards for organizing patient data over time in medical records make it possible to trace connections among the data collected, the patient's problems, the practitioner's assessments, the actions taken, the patient's progress, the patient's behaviors and ultimate outcomes.

Two basic standards of care, and corresponding tools, bring order and transparency to medical decision making:

- First, from the outset of care, relevant patient data must be chosen, and its implications determined, based on the best available medical knowledge, independent of the limited personal knowledge of the practitioners involved. Patient data must be systematically linked to medical knowledge in a combinatorial manner, *before* the exercise of clinical judgment, using information tools to elicit all possibilities relevant to the problem situation, while defining and documenting the information taken into account. Practitioners' clinical judgments may add to, but must not subtract from, high standards of accuracy, completeness and objectivity for that information.
- Second, in complex cases, particularly in cases of chronic disease, the organization of data in medical records must be optimized for managing multiple problems over time. This means that each medical record must begin with a complete list of carefully defined patient problems, and that other clinical information in the record must be linked to the problem or problems to which it relates. Without that structure for the medical

record, decisions are made out of context, follow-up and coordination of care are haphazard, and records are not usable for rigorous clinical research.

With these two basic standards of care, and the information tools needed to implement them, practitioners and patients can manage the flood of detailed information required for sound decision making over time. With this detailed information, made usable for research in structured electronic medical records, medical care can become increasingly refined and individualized. In contrast, so-called "evidence-based medicine" is derived from large population studies that fail to account for the medical uniqueness of each patient.

Enforcing the necessary standards and tools depends on changing medicine's culture of professional autonomy for highly educated physicians. Indeed, the concept of a physician as we know it is not viable. All practitioners must submit to meticulous definition and control of their inputs to care (a principle recognized by the patient safety movement). The primary barrier to this cultural change is graduate medical education and credentialing. These social institutions (1) fail to define, disseminate and enforce high standards of quality for provider inputs to care, (2) inhibit effective design and use of information technology to manage clinical information, and (3) suppress competition among providers who might otherwise exploit information technology to generate remarkable advances in patient care and medical knowledge.

I. *Introduction: Building a New System*

It is in vain to expect any great progress in the sciences by the superinducing or engrafting new matters upon old. An instauration must be made from the very foundations, if we do not wish to revolve forever in a circle, making only some slight and contemptible progress.

— Francis Bacon¹

A culture of denial subverts the health care system from its foundation. The foundation—the basis for deciding what care each patient individually needs—is connecting patient data to medical knowledge. That foundation, and the processes of care resting upon it, are built by the fallible minds of physicians. A new, secure foundation requires two elements external to the mind: electronic information tools and standards of care for managing clinical information.

Electronic information tools are now widely discussed, but the tools depend on standards of care that are still widely ignored. The necessary standards for managing clinical information are analogous to accounting standards for managing financial information. If businesses were permitted to operate without accounting standards, the entire economy would be crippled. That is the condition in which the \$2½ trillion U.S. health care system finds itself—crippled by lack of standards of care for managing clinical information. The system persists in a state of denial about the disorder that our own minds create, and that the missing standards of care would expose.

This pervasive disorder begins at the system's foundation. Contrary to what the public is asked to believe, physicians are not educated to connect patient data with medical knowledge safely and effectively. Rather than building that

¹ Bacon F. *Novum Organon* (1620), Summary of the Second Part, Aphorisms Concerning the Interpretation of Nature and the Kingdom of Man, Aphorism No. 31 (Montague, trans., 1854); at <http://history.hanover.edu/texts/Bacon/APHOR.html>.

secure foundation for decisions, physicians are educated to do the opposite—to rely on personal knowledge and judgment—in denial of the need for external standards and tools. Medical decision making thus lacks the order, transparency and power that enforcing external standards and tools would bring about.

A simple example will illustrate medicine’s missing foundation. Consider a person with chest pain. Careful review of the literature shows that a practitioner investigating this symptom needs to take into account approximately 100 diagnostic possibilities, involving most medical specialties. Each diagnostic possibility is definable as a combination of simple, inexpensive findings from the history, physical and basic laboratory tests. Checking all of the findings for all of the diagnostic possibilities results in approximately 440 findings on each patient. Each positive finding suggests one or more of the diagnostic possibilities. Each patient’s particular combination of positive findings can be matched against all of the combinations of findings representing the diagnostic possibilities for chest pain. The output of this matching process is an *individualized* set of diagnostic possibilities, plus the patient’s positive and negative findings for each. These findings constitute initial evidence for and against each possibility. The total set of possibilities (i.e. those for which at least one positive finding is made) represents the diagnoses worth considering for that patient. External tools generate this output by simple matching, without dependence on the fallible minds of costly physicians. The tools distill this output from the accumulated experience of countless patients and practitioners—experience that would be otherwise lost.

This meticulous matching process is feasible only with software tools. The minds of physicians do not have command of all the medical knowledge involved. Nor do physicians have the time to carry out the intricate matching of hundreds of findings on the patient with all the medical knowledge relevant to interpreting those findings. External tools are thus essential. But the tools are trustworthy only when their design and use conform to rigorous standards of care for managing clinical information.

Without the necessary standards and tools, the matching process is fatally compromised. Physicians resort to a shortcut process of highly educated guesswork. They begin with guesses about diagnostic possibilities that might account for the chest pain. Sometimes very sophisticated, these initial guesses lead to further guesswork about what to check during the initial history, physical examination and laboratory tests for investigating whatever diagnostic possibilities come to mind. And then physicians make more guesses about what the data mean, which in turn shapes their judgments about what further data to collect. Varying from one physician to another, these highly educated guesses are not explicit—

physicians do not carefully record their thinking or the information they take into account. Inputs to decision making are thus undefined.

We use the term “guesses” because these key initial judgments are made on the fly, *during* the patient encounter, based on whatever enters the physician’s mind at the time. That mind may be highly informed and intelligent, but inevitably its judgments reflect limited personal knowledge and experience, and limited time for thought. Euphemistically termed “clinical judgment,” physician thought processes cause a fatal voltage drop in transmitting complex knowledge and applying it to patient data. The outcome is that the entire health care enterprise lacks a secure foundation.

Equally insecure are the complex processes built on that foundation: decision making, execution, feedback and corrective action over time. Responsibility for all these processes falls on the mind of the physician. Here again the mind lacks external tools and accounting standards for managing clinical information.

Medical practice is thus trapped in a subjective realm. Unlike scientific practitioners, medical practitioners do not operate in an objective realm, where the *contents* of thought and knowledge exist independently of the individual mind, a realm where knowledge can be reliably transmitted and applied, where new knowledge can be rapidly translated into practice, where all knowledge can be tested against patient realities. Isolated from this objective realm, the mind becomes a negative force, a cause of confusion and disorder. Physicians are not equipped to fulfill their immense responsibility safely and effectively. Other practitioners are not equipped to share that responsibility with physicians. Patients are not equipped to work effectively with multiple practitioners, nor to assume the ultimate burden of decision making over their own bodies and minds. Third parties are not equipped to create order out of this chaos. Practitioners and patients are not accountable for their own behaviors, while third parties are left free to manipulate disorder for their own advantage.

In short, essential standards of care, information tools and feedback mechanisms are missing from the marketplace. These missing elements are in large part already developed (see parts IV and VI below). Yet, the underlying medical culture does not even recognize their absence. This does not prevent some practitioners from becoming virtuoso performers in narrow specialties or skills. But their virtuosity is personal, not systemic, and limited, not comprehensive. Missing is a total system for enforcing high quality care by all practitioners for all patients.

Medical school fills this vacuum with harmful habits and illusions that physicians find difficult to let go. Credentialing then confers a legal monopoly on physicians, insulating them from competition and preserving their illusions. The resulting state of denial blocks development of a secure, orderly, integrated system of defined inputs, tight feedback, clear accountability, and continuous improvement in patient care.

A system of that kind (see the diagram at the end of this Introduction) is the subject of this book. At first glance, this subject matter may seem like just a variation on current policy concerns with using “health information technology” to bring “evidence-based medicine” to “patient-centered” care. Yet, current policy fails to comprehend the needed discipline in medical practice and thus fails to define precisely what is needed from health information technology. A dangerous paradox thus exists: the power of technology to access information without limits magnifies the very problem of information overload that the technology is expected to solve. Solving that problem demands a meticulous, highly organized, explicit process of initial information processing, followed by careful problem definition, planning, execution, feedback, and corrective action over time, all documented under strict medical accounting standards. When this rigor is enforced, a promising paradox occurs: clarity emerges from complexity.

No such relief from complexity is in sight now. A wide gap exists between current reform initiatives and the disciplined medical practice that patients need. This gap exists regardless of whether health care is public or private, and regardless of whether health care spending is provider-driven (traditional fee-for-service medicine), payer-driven (managed care) or now “consumer-driven.” Until the gap is closed, attempts at cost control and quality improvement will continue to revolve in a circle, without sustainable progress.

In contrast, were we to close the gap between medical practice and patient needs, society then could find enormous opportunities to harvest resources now going to waste. These wasted resources include not only vast sums spent on low-value care but also a vast body of medical knowledge that all patients and practitioners could use more effectively, simple tests and observations that in combination could uncover solutions to patient problems, patients who could become better equipped and motivated to improve their own health behaviors, routine patient care that could become a fertile source of new medical knowledge, and the firsthand insights of practitioners and patients who could participate in harvesting that new knowledge for their own benefit.

Closing the gap between medical practice and patient needs would transform how medicine is personally experienced by practitioners and patients alike.

Practitioners could find their work to be less exhausting and more rewarding, emotionally and intellectually, than what they now undergo. The physician’s role could disaggregate into multiple roles, all freed from the impossible burdens of performance that physicians are now expected to bear. The expertise of nurses and other non-physician practitioners could deepen, and their roles could be elevated. All practitioners could follow time-honored standards of care that in the past have been honored more in the breach than the observance. All practitioners and patients could jointly use electronic information tools for matching data with medical knowledge, radically expanding their capacity to cope with complexity. All could use structured medical records, whose structure would itself bring order and transparency to the complex processes of care. Inputs by practitioners could thus be defined and subjected to constant feedback and improvement. A truly evidence-based medicine could develop, where evidence would be used to individualize care rather than standardize it. And a system of checks and balances could develop, where patients and practitioners would act on incentives for quality and economy far more effectively than before.

Were such a transformation to occur, each patient/consumer could engage in health care as a personal pursuit, navigating the health care delivery system as a transparent network for that purpose. Compare the transportation system—like health care, a system where public safety is at stake. Travelers rely on expert service providers when needed (pilots, auto mechanics, travel agents, for example), but the primary decision makers are travelers themselves. They determine the destination, the route, and the mode of travel for a journey. And their decisions are highly individualized. Two different people driving across the country might choose completely different routes, depending on whom and what they wish to visit and what they encounter along the way. Because such factors are variable, the choice of routes among different travelers is variable. No one would regard such variation as inappropriate. No one would expect travelers to conform to some “evidence-based” determination by experts of the “best” route across the country. Similarly, in medicine, no one should think that two different people labeled with the “same” disease necessarily have comparable medical needs. No one should think that the care of unique individuals must conform to “evidence-based” guidelines derived from “comparative effectiveness research” on large population databases. Effectiveness is context-specific. High quality, efficient care would thus emerge case-by-case, each person finding a different pathway in a progression of many small steps, with each step carefully chosen, reliably executed and accurately documented. Researchers could then study and correct any difficulties at each step, thereby assuring a better outcome for those

who use that step in reaching their goal. This would mean continuous, incremental improvements throughout the medical landscape.

Like the transportation system, the health care system should be usable by ordinary consumers when feasible. In travel, rather than relying on taxi drivers, we learn to drive and we buy our own cars. Instead of hiring engineers to tell us what cars to buy, we read *Consumer Reports* and judge our personal needs and preferences for ourselves. Rather than hiring guides, we read maps and road signs, choosing routes for ourselves. Coming and going in all directions, we collectively shape the system with our choices. Experts and regulators then obtain feedback for system improvements.

In some modes of travel (rail and air), we depend on expert service providers, but we as consumers, not those experts, choose the mode of travel. By comparison, if transportation were like health care, then experts in the costliest mode of travel would monopolize authority to choose and the entire system would be distorted: pilots would decide when consumers travel by air, unnecessary flights for short distances would be routine, unnecessary airports would be built, the infrastructure for other modes of travel would be underdeveloped, and the choices available to consumers would be restricted.

Consumers in the transportation system depend on reliability of the infrastructure and transparency in the rules for its use. Consider auto transportation. Roads and bridges are maintained in drivable condition. Maps, road signs and electronic systems are provided for navigation. Drivers are licensed and cars inspected. Traffic laws are defined and enforced. Traffic patterns are monitored, safety threats are identified and each element of the infrastructure is improved as needed. Statistical information is used to inform these improvement efforts, not to prescribe “evidence-based” routes that travelers must follow. As a result, drivers can choose their routes, find their destinations and arrive safely. The primary risk to safety is the behaviors of other drivers, not breakdowns in the transportation system. In contrast, breakdowns in the safety, quality and economy of health care are epidemic.

Consider also airline safety regulation. It carefully defines inputs by workers with specialized expertise, and they function within an integrated system, every component of which is subject to strict scrutiny and control. Airline mechanics, for example, are subject to strict recordkeeping and inspection requirements. Pilot credentials are based not on formal education but on periodic demonstration of actual competence in flying specific classes of plane. Air traffic control systems, sophisticated cockpit instrumentation and detailed standards of care govern the actions of expert pilots. Pilots do not have professional autonomy.

They function within a protective system that is meticulously monitored. As a result, airline travel is so safe that no one chooses among airlines by comparing crash rates or pilot credentials.

Our description of the transportation system is, of course, oversimplified and idealized. But this underlines our point. Even with its failings, the transportation system is still far superior to the health care system in the quality of its parts and their connections.

In any complex system, all parts must be reliable and oriented towards a common general purpose, a purpose that different individuals specify and pursue in their own ways. The connections must generate corrective feedback loops, so that individual and collective actions remain compatible with the common general purpose.

In medicine that purpose is individualized medical problem solving. For that purpose, the health care system will never be trustworthy or affordable until its parts and their connections are reformed in three key respects. Indeed, health care’s recent evolution is turning in these directions:

- *Inputs by practitioners must be carefully defined and controlled.* During the last 15 years, this development has begun to take root. The patient safety movement has demonstrated over and over again the need to define and control inputs from fallible human beings. But this development has focused largely on execution of decisions. Decision making itself equally needs definition and control of inputs from the human mind. Left to its own devices, the mind is unreliable and not well connected to other system components on which its inputs depend. Medical education and credentialing block the necessary changes in this regard. To bring inputs under control, the legal monopoly of physicians over medical practice must end, while medical education and credentialing for all practitioners must focus on instilling a core of behavior, not a core of knowledge. That means licenses to practice must be based on actual performance under standards of care defined by the system, not on learning fragments of the vast knowledge built into the system.
- *A trustworthy and transparent intellectual infrastructure for care must be established.* During the last 15 years, the Internet has revolutionized access to expanding medical knowledge. But the human mind cannot apply complex knowledge effectively without external aids. Practitioners and patients trying to navigate the medical landscape need two information tools: a map of the landscape and a communication system for the journey

(see parts IV and VI below, respectively). The map (tools for coupling medical knowledge with patient-specific data) reveals the landscape so that individuals can find routes fitting their personal needs (unlike “evidence-based” travel directions dictated in advance). The communication system (structured medical records) enables the patient and multiple practitioners to coordinate their actions, planning and recording each step of the journey, informed by continuous feedback. With this infrastructure, all practitioners and consumers can apply complex knowledge to detailed data, and readily understand how their efforts interrelate.

- *The central role of the patient/consumer must be recognized.* During the last decade, this recognition has become increasingly evident in two areas: consumer-driven health care and management of chronic illness. But these developments are incomplete. The consumer-driven care movement focuses more on spending than care. In management of chronic illness, many organizations have developed approaches for helping patients manage their own conditions, but these disparate efforts are not unified by common tools and standards applicable in all medical contexts. The missing tools and standards exploit basic principles of orderly problem-solving that everyone grasps. With that simplicity and unity, the health system becomes transparent and usable for all.

We need to see health care not as an esoteric domain for specialized experts but as a universal human pursuit. To enable that pursuit, the culture of medicine and its intellectual infrastructure must both be transformed, reoriented towards individualized medical problem solving by and for each unique patient. That orientation differs fundamentally from evidence-based medicine, payer-driven managed care and traditional, provider-driven medicine. These are all variations on the same vendor-driven non-system of care. These variations are disconnected from patient needs because a truly consumer-driven system of care has yet to be built.

To present these concepts, we begin with a detailed case study (part II.A). Then we analyze some of its implications (parts II.B and III). Next, we describe two information tools², the standards of care they implement (parts IV and VI)

² Specifically, the information tools are (1) decision support software designed for coupling medical knowledge with patient data, and (2) electronic medical records designed to organize care around patient problems instead of provider habits. Known respectively as knowledge coupling software and the problem-oriented medical record (POMR), these tools implement standards of care for managing medical information, as discussed in parts IV and VI below. Some basic references are Weed, LL., et al., *Knowledge Coupling: New Premises and New Tools for Medical Care Education*, New York: Springer-Verlag, 1991 (see especially chapter 13 of this volume,

and their relationship to the domains of science and commerce (part V). Finally, we analyze implications for the development of medical knowledge, medical education, and the patient’s role (parts VII, VIII and IX, respectively). The diagram following this Introduction shows the basic elements of a total system of care. Appendix A analyzes two clinical trials of the software tools discussed in part IV. Appendix B further analyzes the patient’s role.

All readers should begin with the case study in part II.A, which later sections reference repeatedly. After the case study, readers whose most immediate interests are the standards and tools for clinicians may wish to proceed directly to parts IV and VI. Other readers may wish to read each part sequentially. Regardless, each part is best understood in light of all the others. Reading the entire book is essential to fully understanding its core ideas. The following outline of Parts II to IX should further help orient the reader.

II *Disorder in medical practice.* This part begins with a detailed case study of a missed diagnosis, showing why accepted practices inevitably produce such cases. Then we analyze some basic implications for reform of medical practice. The central concept is that medicine needs a new division of intellectual labor. Decision making must begin with a simple, mechanical process of association between data and knowledge, conducted without reliance on the practitioner’s mind. Thereafter, the processes of care must remain highly organized and explicit. Care would become highly standardized at the front end, and medical decisions at the back end would become highly individualized—precisely the opposite of the status quo, where physicians have broad discretion during the initial patient encounter but are expected to conform to standardized, “evidence-based” guidelines in their ultimate decisions. Enforcing this change makes possible fundamental health care reform at many levels.

III *The concept of defined inputs.* This part explains the necessity for defined inputs by practitioners. Defining inputs does not mean dictating medical

authored by Dr. Ken Bartholomew, who describes in detail use of knowledge coupling software in conjunction with the POMR in a primary care practice); Weed, LL et al., *Medical Records, Medical Education and Patient Care*, Cleveland: Case Western Reserve University Press (1969); Weed LL. Medical records that guide and teach. *N Engl J Med* 1968 Mar 14;278(11):593-600; Bjorn J, Cross H. *The Problem-Oriented Private Practice of Medicine*. 1970. Chicago: Modern Healthcare Press, pp. 24-28; Burger, Charles S., “The Use of Problem Knowledge Couplers in a Primary Care Practice”, *Healthcare Information Management*, vol. 11, no. 4, Winter 1997; C.C. Weed. *The Philosophy, Use and Interpretation of Knowledge Couplers*. PKC Corporation, 1982-2008, available at www.pkc.com; Weed LL, Weed L. Opening the black box of clinical judgment, *British Medical Journal, eBMJ Edition*, Vol 319, issue 7220, 13 November 1999, available at <http://bmj.bmjournals.com/cgi/content/full/319/7220/1279/DC2>.

decisions (the direction taken by managed care and evidence-based medicine). Rather, it means enforcing comprehensive standards of performance at a high level, while preserving freedom to exceed those standards. Feedback loops then generate continuous, evolutionary improvements (enforcement against variations for the worse and adoption of variations for the better). This focus on inputs differs fundamentally from current alternatives focused on outcomes or financial incentives or quality indicators. Evidence-based medicine, for example, imposes generalized standards derived from outcomes in large populations, while failing to account for the individual differences that determine outcomes and failing to develop the external tools needed to apply individualized standards.

- IV *Coupling patient data with medical knowledge:* This part focuses on the initial patient workup, where the foundation for care is laid, but the concepts discussed apply more broadly. This part distinguishes between two alternatives—labeled the combinatorial and judgmental approaches—for applying medical knowledge to patient data. Unlike the judgmental approach, the combinatorial approach can be performed by external tools. The basis for choosing between the two approaches is discussed, and “knowledge coupling” tools designed to implement the combinatorial approach are described. See the diagram below, which shows the institutional arrangements within which the tools are built. The combinatorial approach enforces standards of care far more rigorous than accepted medical practice. Physicians object to these standards on various grounds. Answering those objections in detail leads to exploring clinical judgment, the stages of decision making, the nature of medical expertise—in short, the epistemology of medicine. We find that medical practice embodies an unscientific notion of expertise.
- V *Historical and philosophical background:* Pausing from the clinical discussion, this part explores the intellectual behaviors that the combinatorial approach embodies—behaviors that Francis Bacon identified 400 years ago at the birth of modern science. We emphasize a crucial distinction (articulated by Karl Popper) between subjective thought residing in the mind and the objective contents of thought residing in external texts and devices (part V.A). We then tie these issues to F. A. Hayek’s analysis of economy of knowledge in market systems, where people constantly avail themselves of knowledge they do not individually possess (part V.B). In health care, people need tools to avail themselves of both knowledge and processing

power they do not possess. The tools require simple rules for managing clinical information, just as market systems require accounting standards for managing financial information. This argument views health care as a complex adaptive system, but one that lags centuries behind the evolved systems in the domains of science and commerce.

- VI *The medical record:* Returning to the clinical discussion, this part examines the medical record as a tool for managing detailed patient data over time, after the foundation is laid in the initial workup. The medical record is critical for complex cases involving chronic disease and multiple problems, which is where the largest amount of health care resources are consumed. Medical record standards should be structured to provide simple rules to manage complexity. This means the record should reflect the basic, common-sense steps of orderly problem solving: gathering information, defining problems, formulating plans to address each problem in light of the others, and following through on each plan in light of ongoing feedback. This problem-oriented structure makes possible a unitary medical record for each patient, a record that enables coordinated care by all practitioners, informed involvement by the patient, scientific rigor by clinical researchers, effective scrutiny by third party payers and regulators, and feedback for the total system of care described in the diagram below.
- VII *The nature of medical knowledge as applied to patient care:* This part distinguishes between population-based knowledge about resemblances and patient-specific knowledge about variation among individuals. The latter form of knowledge becomes comprehensible and manageable with new tools and standards for managing information. Moreover, taking into account the medical uniqueness of individuals overcomes the ethical and epistemological limitations of evidence-based medicine. Further, development of medical terminology, taxonomy and coding should be driven not by unstructured clinical judgments of physicians but rather by knowledge coupling tools derived from and linked to a network of medical knowledge that in turn is distilled from the medical literature and continuously improved by analysis of medical records, as diagrammed below.
- VIII *Medical education and credentialing:* This part begins by describing how medical schools still fail to integrate clinical and basic science a century after the Flexner Report. Medical education and credentialing must change from a knowledge-based to a skills-based approach. The traditional

knowledge-based approach fails to exploit the power of information technology, it completely undermines definition and control of provider inputs to care, and it is educationally harmful. A skills-based approach would use John Dewey’s concept of knowledge as a “network of interconnections,” embodied in information tools, used by students to access and apply medical knowledge rather than learn it. Learning a core of behavior rather than a core of knowledge, students would be educated from actual experience in patient care. In addition to its educational benefits, this approach would make it possible to rationalize the division of labor in medical practice, further transforming the quality and economics of health care.

IX *Education and the patient/consumer’s central role:* This part first analyzes concepts of consumer-driven care, and patient-centered care in the “medical home,” arguing that these concepts depend on new tools and standards of care for managing clinical information. Those tools and standards are essential to creating a culture where patients/consumers take responsibility for managing their chronic disease and improving their health behaviors. We argue that patient responsibility requires patient autonomy, which goes beyond the concept of patient-centered care. That discussion leads to the issue of medical education for patients/consumers. Their central role demands that health care should be a subject of formal education from childhood. But formal education, for both practitioners and consumers, must be reformed to break down the usual separation between learning and doing, knowledge and behavior, as John Dewey argued. Health care is the ideal subject matter for applying this reform. From this point of view, we may some day look back on today’s school and university education in much the way we look back on alchemy and astrology in the time of Francis Bacon.

Appendix A: Here we analyze two clinical trials of the tools discussed in part IV, concluding that clinical trials have limited value in this context. This Appendix expands on part IV.D, which discusses the problem of evaluating reforms of medical practice.

Appendix B: Here we include a copy of “Scientific principles that tell us why people must manage their own health care,” the introduction to a book written for patients in 1975.

The following diagram shows the relationships among the basic components of individualized health care delivery and knowledge development systems.

