

# Healthcare information technology and economics

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## ABSTRACT

At the 2011 American College of Medical Informatics (ACMI) Winter Symposium we studied the overlap between health IT and economics and what leading healthcare delivery organizations are achieving today using IT that might offer paths for the nation to follow for using health IT in healthcare reform. We recognized that health IT by itself can improve health value, but its main contribution to health value may be that it can make possible new care delivery models to achieve much larger value. Health IT is a critically important enabler to fundamental healthcare system changes that may be a way out of our current, severe problem of rising costs and national deficit. We review the current state of healthcare costs, federal health IT stimulus programs, and experiences of several leading organizations, and offer a model for how health IT fits into our health economic future.

## INTRODUCTION

US investment in health information technology (IT) has risen substantially since 2008 while the focus on the national deficit and rising healthcare costs has sharpened. This convergence makes it opportune to review how health IT can influence healthcare spending and provide financial return on the nation's investment in it. The overlap between health IT and economics was the theme of the 2011 American College of Medical Informatics (ACMI) Winter Symposium at which invited guests and ACMI fellows presented perspectives on this issue, and studied the current achievements of leading healthcare delivery organizations for insights into the paths the nation might follow in using health IT in healthcare reform.

We recognized, in summary, that health IT by itself can improve health value (defined as utility/costs), but its main contribution to health value may be that it can make possible new care delivery models to achieve much greater value. Thus, health IT is a critically important enabler of fundamental healthcare system changes that may provide a solution to our current, severe problem of rising costs and national deficit. If true, national investment in health IT is extremely important now as we struggle to decide among competing alternatives for the future of the American healthcare system.

In this article, participants in the ACMI meeting review the current state of healthcare costs, federal programs to stimulate use of health IT, and the experiences of several leading organizations, and then offer a model for how health IT fits into the

economic future of our health. We concentrate on topics discussed during this meeting, but do not address many other topics important to analysis of the relationship between health IT and economics, including (but not limited to) current reliance on billing data with less attention given to ontologies and terminologies, patient safety and its enormous economic implications, privacy, translational bioinformatics, population health, and healthcare equity.

## THE STATE OF CURRENT HEALTHCARE COSTS AND HEALTH IT PLANS

The USA likely spends too much money on healthcare. In 2005, expenditure on healthcare was \$6041 per capita, more than double the median of \$2922 spent in the 30 industrialized countries of the Organization for Economic Cooperation and Development.<sup>1</sup> By 2008, annual per capita healthcare spending had risen to \$7681, with a total for the nation of over \$2.3 trillion, three times the 1990 estimate.<sup>2</sup> Expenditure growth has exceeded overall cost inflation and GDP growth every year for the last 10 years and, without structural changes, this trend is expected to continue. Roughly, 31% is spent on hospital care, 21% on physician services, 10% on prescription drugs, and 8% on nursing home care, with the remaining 30% spread over capital investment, insurance profits, administrative costs, home health, public health, and other health-related items.<sup>2</sup> Meanwhile, the USA, as of 2006, ranked 39th for infant mortality, 43rd for adult female mortality, 42nd for adult male mortality, and 36th for life expectancy.<sup>3</sup> The high spending level has numerous causes, including the fee-for-service payment system, the lack of a national single-payer system, the entrepreneurial nature of the healthcare industry, the continued embrace of high technology testing and treatment modalities, and the well-documented geographic disparities in age- and income-adjusted utilization and expenditures, up to threefold, with minimal health benefit resulting from higher expenditure.<sup>4</sup>

## The consequences of high healthcare costs

The US employer-based system for insuring the healthcare costs of working Americans and their families covers 160 million people. According to the National Association of Manufacturers, 97% of its members provide health insurance, with highly variable and decreasing coverage and increasing co-pay provisions. Many smaller employers do not offer or do not subsidize insurance. The National Association of Manufacturers reports that insurance

costs between 1999 and 2009 increased by 119%, putting US employers at a disadvantage in the global economy. An estimated 48 million Americans lack private or public health insurance altogether and a large number have inadequate insurance coverage. The Patient Protection and Affordable Care Act of 2010<sup>5</sup> is intended to extend coverage to most Americans if fully implemented in 2014.

For the Federal government, healthcare expenditures via Medicare and Medicaid are a major impediment to controlling the expanding Federal deficit. Studies by the Congressional Budget Office, the Commonwealth Fund, and the Institute of Medicine have documented the unsustainable nature of the excessive growth in healthcare expenditures for Federal and state governments and for the economy. 'Bending the curve' of cost increases downward to be much closer to annual growth in GDP starting now would be a much less drastic scenario than enduring the deep cuts otherwise certain to be required eventually. Against a backdrop of negligible overall inflation and a reduction in tax revenues, Medicare spending grew by 7.9% each year in 2008 and 2009 to \$502 billion, while Medicaid spending grew by 4.9% and 9.0% to \$374 billion, driven in part by a 7.4% increase in Medicaid enrollment.<sup>6</sup> The Department of Veterans Affairs (VA) and the Department of Defense healthcare expenditures also experienced large increases, reflecting the current wars, the generous benefit provisions, and the effects of the economy on patterns of use.

It is in this healthcare financial milieu in which the nation is making a substantial investment in health IT, described in the following section.

### Overview of current national health IT initiatives

The US government is making an unprecedented investment in health IT of nearly \$30 billion through the HITECH Act. Most of the money will be spent as incentives to eligible providers and organizations for adopting and using electronic health records (EHRs).<sup>7</sup> The legislation requires providers to use certified EHRs, participate in clinical data exchange, and report quality metrics. To be eligible for the incentives, providers and organizations have to demonstrate that they are using EHRs in meaningful ways, as specified in an evolving definition of 'meaningful use.' This concept was proposed in the legislation because studies suggest that simply owning EHRs is not associated with higher levels of quality<sup>8,9</sup> and the intent of the HITECH Act is to improve the quality, safety, and efficiency of care.

The HITECH incentives are intended to act in concert with other areas of healthcare reform to increase efficiency and improve quality, such as the development of accountable care organizations and bundled payment, whereby providers will share a single payment for an entire episode of care. The Office of the National Coordinator for Health Information Technology has provided a number of other types of support, including regional extension centers to assist providers with adoption, support for implementing exchange of health information, the Beacon Community Program to demonstrate effective approaches to healthcare quality improvement using IT, and development of health IT research centers.

### THE ROLE OF IT IN REDUCING THE COSTS AND IMPROVING THE QUALITY OF HEALTHCARE

In transforming healthcare to control costs and improve outcomes, IT has been recognized as an essential tool in a series of reports by the National Academy of Sciences.<sup>10-13</sup> It can do this in several ways as described below.

### Providing detailed information about healthcare

Properly adjusted, up-to-date data on healthcare utilization, quality, access, and inequalities, on population health and risk factors, and on financial and budget parameters can inform decisions by providers, insurers, government payers, patients, and families. Patient-level, provider-level, system-level, geographic, and national longitudinal and cross-sectional data are needed for a wide range of purposes.

Obtaining, managing, and using this information requires health information technologies. The cost to acquire, maintain, and operate the technologies may be offset, at least in part, by savings in such areas as maintaining records and by increased revenues from improved billing and collections. Health IT also produces efficiencies in communication and administrative functions.

### Cost reduction in the care of individual patients

A great deal of research has demonstrated that in the care of individual patients, health IT can:

- ▶ Optimize work processes, for example, eliminate searching for charts and multiple entry of information.
- ▶ Facilitate optimal choices, for example, through the use of evidence-based order sets, check lists, predefined dose ranges, drug interaction checks, feedback on quality metrics, and education through linkage to information resources (infobutton technologies).<sup>14</sup>
- ▶ Remind clinicians to perform appropriate preventive health services (pneumococcal vaccination, flu vaccine, and colon cancer screening<sup>15</sup>).
- ▶ Reduce errors through clinical decision support,<sup>16</sup> dose range checks, reminders, and alerts.
- ▶ Facilitate the integration and summarization of data from multiple sources,<sup>17</sup> reduce redundancy of test ordering,<sup>18</sup> and further reduce errors in prescribing.<sup>19</sup>
- ▶ Improve quality and reduce costs in other ways described by many Davies Award winners who provide examples of successful uses of health IT to improve quality and reduce costs.<sup>20</sup>
- ▶ Make clinicians aware of patients' advance directives in timely manner.

### Supporting changes in healthcare delivery

The transformative impact of health IT, however, is not so easily monetized. This includes effects on healthcare quality, safety, and patient-centeredness, on patient and provider satisfaction, and on the organization's reputation, cohesiveness, workplace milieu, responsiveness to urgencies and crises, and effectiveness as a learning organization.

Changes in the structure of healthcare delivery have been important to organizations which have succeeded in managing healthcare costs, above and beyond the efficiencies achieved by health IT in managing individual patients. These include:

- ▶ Engaging patients in their care and in directly collecting data, and thereby also maximizing the use of home and lower-intensity care settings where possible.
- ▶ Facilitating teamwork and more effective use of less expensive personnel through improvements in communication and workflow.
- ▶ Supporting case management and population-based care to identify those needing interventions who have not received them, whether or not they visit a healthcare facility.
- ▶ Facilitating sharing of expertise across distances, giving practitioners access to such services as data analysis and teleconsultation through new systems and communications architectures.

The acquisition of health IT does not automatically confer these benefits, however. To assure effective operation of the technology, skillful planning and implementation are as essential as system design, software functionality, and technical prowess. More fundamentally, the healthcare organization must resolve to reinvent its operations to use the newly available information as a strategic resource for improving both the quality and the economics of its services.

When health IT reduces healthcare costs by eliminating duplicate or unnecessary tests and ineffective or needlessly expensive treatments, or keeps patients out of hospitals or manages them at home, it also reduces revenues to the provider organizations and practices. Likewise, the benefits of longer life and better quality of life do not accrue directly to the organization that has invested in health IT. For these reasons, a number of Federal government initiatives have been designed to realign incentives and promote the adoption and use of health IT to improve the quality of care and lower costs. These initiatives include incentives to reduce costs, improve coordination of care, conduct case management, and assume financial risk and accountability for care.

### IS THERE EVIDENCE HEALTH IT IS WORTH OUR INVESTMENT?

In asking 'Is health IT worth our investment?' we need to analyze several elements of the question. We have given examples in this article, and the literature supplies other evidence, that health IT has been successfully used to control a variety of healthcare costs. These include avoidance of duplicate testing and adverse drug events, conserving providers' time and effort by having information more easily accessible, and cost savings associated with increased efficiency or productivity metrics.<sup>21</sup>

At the same time, we know that the savings described in the literature depend upon the interaction of many factors particular to organizations and the ways they use specific technologies. It would therefore be naive to assume that all organizations adopting health IT will experience the savings described in any given report.<sup>22</sup> In addition, we know that the purchase of health IT does not always translate to active use<sup>23</sup> or 'meaningful use,' benefits are not always realized,<sup>24</sup> many of the benefits involve improved processes that do not directly translate to better patient health outcomes, and, finally, many of the benefits are not easily quantifiable.

To evaluate the wisdom of investing in health IT, then, we address key questions and propose approaches to answering them. We discuss the nature of the *evidence*, examine what we mean by both *health IT* and *investment* and then discuss the challenges of making a determination of *worth*.

### What kind of evidence do we need?

A review of 675 titles from PubMed over the past 5 years, indexed under 'Economics AND Informatics' (both broad categories, with many sub-concepts) shows little new evidence to inform national decisions. There are several cost-effectiveness analyses of health IT in circumscribed domains, such as disease management<sup>25</sup> or nursing homes,<sup>26</sup> although these are outside the USA (Israel and Taiwan, respectively). The influential cost-benefit analysis of 2003 by Wang and colleagues<sup>27</sup> relied on 10 prior articles, plus expert consensus and data local to a single academic health center. A citation search based on this study yielded 134 later studies, with 15 relevant to this section. The focus of these studies was either on adoption,<sup>28</sup> constrained initiatives such as safety programs,<sup>29</sup> small practices,<sup>30</sup> or single specialty clinics.<sup>31</sup>

Part of the difficulty in obtaining appropriate evidence is that we do not routinely collect the data that would enable us to make actual, rather than theoretical, determinations of costs and/or benefits. An actual determination would require us to assess on a continuous basis the costs and other inputs to the systemic intervention of health IT and its economic impacts and other outputs. This is rarely done. In addition, while there have been interesting published data on economic impact (and even there the data are limited), the vast majority of hospitals do not routinely publish the results of their internal analyses. To obtain a generalizable picture of the required investments as well as the realistically expectable economic impacts, we need to think about the additions to and structural changes in the healthcare operational data model that would allow us to routinely collect the data we need and to provide the analyses on a national level. Only then could we truly assess the economic impact of health IT.

Determining the value of these effects can be approached through the methods of cost-benefit analysis and cost-effectiveness analysis, or before-after studies of entire operations. Thus, we can perform a cost-benefit analysis of improved preventive care attributable to health IT. If we can monetize the benefits, we can carry out a cost-effectiveness analysis. Using the traditional \$50 000 per quality-adjusted life year (QALY) threshold, health IT is cost-effective under a variety of assumptions based exclusively on better preventive care.<sup>32</sup> Similarly, health IT-enabled telemedicine, decision support for acute care, and other health IT functionality can be evaluated as clinical interventions that cost money and add QALYs. Since health IT can be very expensive to install and maintain, this is an increasingly important perspective.

Various studies and reviews have reached different conclusions about the impact of health IT on quality and cost.<sup>9 33-35</sup> Potential reasons for the differences in findings include the following: studies considered measures not impacted by IT; studies did not examine whether EHRs were actually used; and studies did not look at the details of the clinical decision support (CDS) in the EHRs and whether the CDS was actually used. Finally, studies did not examine to what extent physicians were trained to use the EHRs in question. Notably, the effects of health IT can be negative as well as positive. Unintended consequences of health IT, sometimes called 'e-iatrogenesis,' include new sources of errors (eg, picking the wrong item from a menu), disruption of clinical workflow and less eye contact with patients, and increased work time for clinicians.<sup>36 37</sup> Thus, it is important to evaluate the efficacy (effect under ideal conditions), effectiveness (effect under real world conditions), and safety of health IT.<sup>38</sup>

### What do we mean by health IT?

We know that health IT interventions are not monolithic. Different functionalities are deployed even within a single system such as an EHR, either hospital or ambulatory (basic EHR, EHR plus clinical decision support, e-prescribing, patient portals, etc) across different sites. Even when the functionalities exist, we know they are not always fully or effectively deployed. Ineffective deployment may result from lack of attention to the cofactors that naturally or necessarily accompany any health IT installation. These include: policies, process re-engineering, training, organizational and human resources restructuring, and management of change. When we speak of health IT, we should always include both the health IT application itself and these cofactors. Finally, there is some evidence that there may be what has been called a 'therapeutic dose effect' of health IT. That is, there is a differential effect of the impact of health IT with varying levels of investment. Johnston *et al* found that ambulatory computerized practitioner order entry (CPOE) provided

a reasonable return on investment only when the most sophisticated systems were deployed.<sup>39</sup> If we have only limited data on the effects of health IT, is it because we have not invested sufficiently overall, or that investments in key cofactors were inadequate? Paradoxically, as Bodell *et al* suggest,<sup>40</sup> is it foolish to invest without the data? To determine the economic impact of health IT, we need to develop clear ways of describing health IT interventions that take account of the functionality, the quality, and the extent of use of those functions.

#### What do we mean by investment and how do we measure it?

Investors are a mix of providers, health systems, and government, where the proportions of the mix depend on the locale, the target population (eg, veterans), the type of health provider, and the policies of the Federal government. Investment requires discussion of who shoulders which part of the investment, over what time horizon the investment should be made and recouped, and how return on investment should be calculated. There are few studies of pure financial return on investment and the field of social return on investment has paid little attention to health IT.

We also do not have clear metrics for characterizing the appropriate costs that should be measured, nor do we have appropriate standards for measuring them. For instance, what must be measured and documented related to IT interventions, and what is the appropriate costing cycle? Potential costs include hardware, network service and maintenance, internal and external IT staffing costs, and others. In addition, cofactor costs are not easily quantified. For instance, while we may be able to estimate the costs of a user-training program, what if the program is badly delivered, what if many participants do not attend, what if they do not learn? What if the program has to be repeated multiple times because of these problems? What if the sophisticated features (the decision support and other workflow features that are more likely to bring a return on investment) are not implemented or used? To make an accurate assessment of the investment, we need to develop metrics that can be used across different health IT systems and different healthcare settings.

Finally, when we speak of 'our investment,' what do we mean by 'our'? Generally, the focus has been on providers and systems, what we could call 'micro-informatics,' paralleling the way that 'micro-economics' focuses on the firm. Evidence here focuses on burden and benefits, again, in a small circle of influence. When the pronoun 'our' refers, however, to the national scope, we are dealing with what we could call 'macro-informatics.' Here, studies should look at societal impact. The paper by Romano and Stafford,<sup>9</sup> reporting a lack of impact of computer-based decision support on health outcomes, generated controversy, as evidenced by the many editorials and comments in the same issue of the journal. The controversies surrounding the Romano and Stafford article only highlight the difficulties in using current data sources to establish a useful, coherent, and (if we may use the word) meaningful body of evidence.

#### How do we determine worth?

Value comes in dollars, productivity, or effectiveness, and the health IT literature focuses primarily on process, then on outcomes, and last on dollars. The majority of efforts, including the development of Federal policy, are aimed at adoption, which presumes worth based on existing evidence. Most of the analytic efforts over the past 5 years have been focused on health information exchanges (HIEs). Given the difficulties in establishing a business case for HIEs,<sup>17 41</sup> such analyses are focusing on a relatively small part of the total value. So, not only do we need

clear measures of the inputs and investments, we need good measures of outputs.

We do not yet know what is realistic to expect from our investments. Further, our expectations may depend on our starting point. For example, a limited IT investment by a small physician practice that has a paper-based system may have a significant impact on the practice, whereas the same level of investment in an already 'wired' practice may have negligible impact. This at least indicates that our results will have to be 'normalized' to some initial state that serves as a common basis for comparison. On the other hand, it is possible that the broader infrastructural support in the more wired practice can enhance the value of even limited investment in health IT and that even substantial investment without the broader support may not produce the desired benefit.

Given the small amount of publicly available evidence, we recommend a focus on how to collect appropriate evidence in the future, rather than providing a concrete answer to the question of the worth of IT that we have raised.

Analyses performed depend on the perspective—the 'our', spelled out above—and the goal. Is the goal to enhance the health of individuals, the population, the community, or all of these? Different analyses would be required, for example, for a build/buy recommendation, a configuration recommendation (eg, centralized versus distributed HIE), a local adoption policy, or a Federal-level policy. In conducting analyses for policy formulation, we recommend the example of the UK's National Institute for Health and Clinical Excellence. Its mandate is not only to establish policy, but also to establish if the evidence base is adequate or if further evidence is required. Value-of-information analyses address these issues and, even more, specify what evidence is needed, and provide an estimate for how many resources should be spent in obtaining the evidence. Of course, if no further information is needed, the question is settled. However, monitoring and situational awareness will remain continuous needs.

#### EXAMPLE OF PIONEERING US HEALTHCARE ORGANIZATIONS IN THE USE OF HEALTH IT

Kaiser Permanente implemented an EHR specifically to transform care and service delivery through improving quality outcomes, enhancing patient satisfaction and engagement, reducing unneeded services and inefficient processes, and increasing population management.<sup>42</sup> Kaiser's health IT project increased the support for primary care, panel ownership, and proactive healthcare management. This has resulted in reduced office visit rates by over a quarter while increasing total patient contacts (including phone and email visits) as well as satisfaction. This occurs in a setting with largely capitated care and therefore the financial incentives to support the necessary investment.

Geisinger's use of health IT supports their efforts to achieve an optimal degree of overlap between financial responsibility and provision of the majority of care. This permits strong financial incentives for quality and to reduce rework and readmission. The organization strives for its workforce members to practice at the 'top of the license,' to increase planned visits and non-office-based visits, and to identify all those for whom the organization provides care and data assigned to them, so that practitioners can manage their care more effectively. Their goal is to measure quality carefully so they can pay for it.

Partners HealthCare has made adoption of IT the cornerstone of its efforts to improve efficiency, safety, and quality, and has rolled out EHRs for all providers and implemented CPOE in all hospitals. The rationale for this investment was to use this as infrastructure

standardized across the network around safety, to improve quality for chronic conditions, and to reduce costs, especially for the use of expensive radiographic studies and medications.<sup>43</sup> Partners has studied a series of innovations aimed at improving safety and efficiency over the years, including CPOE<sup>44</sup> and bar-coding.<sup>45</sup>

The VA has made substantial investment in health IT. Analyses of value from this investment ‘suggest that the VA’s investment in the Veterans Health Information Systems and Technology Architecture is associated with significant value through reductions in unnecessary and redundant care, process efficiencies, and improvements in care quality,’ with an estimated yield of \$3.09 billion in cumulative benefits after subtracting investment costs, by 2007.<sup>46</sup> This health IT investment is associated with improvements in quality<sup>47</sup> and efficiency<sup>48</sup> of care.

These organizations may provide a view of the future of healthcare delivery in the USA. Health IT will be essential for measuring what we do in healthcare through the provision of better information and evidence. They use health IT not to automate paper processes but to leverage transformative changes in the delivery of care. Monitoring quality measures for continual improvement, generating knowledge from clinical data to identify the most effective and least costly interventions, and enhancing communications between and among patients and providers become economically feasible when revenues are based on the quality and effectiveness of the system of care, rather than on the quantity of services. Even if we do not know how, we can see that certain organizations with extensive use of IT have made impressive gains.

Accountable care organizations will need access initially to claims, then, later, to more complete clinical data and patient-generated data such as health risk appraisals and functional status measurements. Data exchange contributes to the gathering of this information, but before data can be exchanged, they must be in electronic form and share common terminologies and other characteristics to support interoperability.<sup>17</sup> Accountable care organizations will depend on a robust health IT infrastructure as will better coordination among hospital, outpatient, specialist, and primary care.

We need to emphasize that, until there is some balance and alignment between investment in health IT and benefit, much and perhaps most of the benefits will accrue to organizations that serve as both payer and provider. This is true for some of the examples we have given, but not for the vast remainder of US healthcare.

## CONCLUSIONS

Health IT has been widely recognized as essential to achieving national goals of reducing the cost of healthcare while improving quality, safety, access, and equity. Health IT can serve as the foundation for eliminating duplicated services, reducing error, and otherwise improving the care of individual patients, by supporting fundamental changes in care delivery models, and by providing detailed information on the processes and outcomes of the care of populations. Methods to measure the impact of health IT on these national goals, however, are not well developed. Assessment of health IT’s economic impact is complicated by variability in the technologies and their functions, and in the application of these technologies, and by their interaction with multiple organizational and user factors. Analyses will vary by scope and scale; for example, cost savings at the national level may translate to lost revenues at the local level. We recommend concentrated efforts to define an operational data model for healthcare organizations that will include variables needed to measure the impact of health IT at the local

organizational level and that can be aggregated at the national level. Work must be done to assign costs and values to the inputs and the outputs of the economic equation, taking into account the perspectives of the various stakeholders and the many cofactors of health IT. Only when such a model has been designed and widely implemented can we reliably assess the economic impact of health IT.

Studies on return on investment in health IT are few, and are unlikely to be rigorously and convincingly performed. Nevertheless, strong support for the value of health IT comes from the observation that organizations succeeding in controlling costs (eg, by supporting self-care and care management) have made large investments in IT, and feel that health IT is essential to their success with these efforts. We believe the same is true for our country.

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