MarketWatch

The Value Of Health Care Information Exchange And Interoperability

There is a business case to be made for spending money on a fully standardized nationwide system.

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ABSTRACT: In this paper we assess the value of electronic health care information exchange and interoperability (HIEI) between providers (hospitals and medical group practices) and independent laboratories, radiology centers, pharmacies, payers, public health departments, and other providers. We have created an HIEI taxonomy and combined published evidence with expert opinion in a cost-benefit model. Fully standardized HIEI could yield a net value of $77.8 billion per year once fully implemented. Nonstandardized HIEI offers smaller positive financial returns. The clinical impact of HIEI for which quantitative estimates cannot yet be made would likely add further value. A compelling business case exists for national implementation of fully standardized HIEI.

Attention to the use of information technology (IT) in health care is intensifying rapidly, with President George W. Bush calling for widespread adoption of electronic medical records (EMRs) within the next ten years.[1] In addition to digitizing the information that providers use to care for their patients within organizations, clinicians, patients, and policymakers are looking ahead to sharing appropriate information electronically among organizations. David Brailer, newly appointed national health information technology coordinator, recently called for expansion of such interoperability to the flow of clinical and other administrative data, citing its importance for encouraging health care IT investment and facilitating health care reform.[2]

To explore the qualitative and economic implications of health care information exchange and interoperability (HIEI), we studied the value of electronic data flow between providers (hospitals and medical group practices) and other providers, and between providers and five stakeholders with which they exchange information most commonly: independent laboratories, radiology centers, pharmacies, payers, and public health departments. We hypothesized that the clinical benefits of electronic data exchange would be substantial

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and that financial benefits would outweigh costs. In this paper we report on the results of our analysis.

Study Data And Methods

We used a range of methods to gather evidence, including literature reviews, expert interviews, and estimates by an expert panel. We focused our efforts on analyzing published sources for data but, where these were lacking, turned to experts to fill critical gaps. We then created a cost-benefit model to project value to organizations and to the country. A full project report that contains a detailed description of the methods we employed is forthcoming.[3]

■ **Literature review.** We worked with a medical librarian to complete a systematic review of the U.S. literature addressing the clinical, financial, and organizational value of HIEI in these interorganizational relationships, and we also searched trade press, general press, and online sources. Not surprisingly, given the lack of real-world implementation of interoperable systems in health care, we found few sources targeting HIEI value specifically.

■ **Experts.** We convened a panel of nationally known experts to advise us throughout this project. They brought expertise in regional data-sharing initiatives, economics, public health, payment systems, informatics, and public policy. With relatively little research and literature on the value of HIEI, the panelists played an important role, participating in structured telephone interviews, a one-day meeting, e-mail polling, and discussions. We also interviewed more than twenty other experts, including provider information systems executives working with various facets of interoperability and directors of regional data-sharing initiatives. The panelists and other experts helped identify data sources and estimated key data points that were not available in published sources.

■ **Analytic framework.** We devised a conceptual framework describing how health care entities share information and created a functional taxonomy reflecting the amount of human involvement required, the sophistication of IT, and the level of standardization. The taxonomy has four levels. Level 1: Nonelectronic data—no use of IT to share information (examples: mail, telephone). Level 2: Machine-transportable data—transmission of nonstandardized information via basic IT; information within the document cannot be electronically manipulated (examples: fax or personal computer [PC]–based exchange of scanned documents, pictures, or portable document format [PDF] files). Level 3: Machine-organizable data—transmission of structured messages containing nonstandardized data; requires interfaces that can translate incoming data from the sending organization's vocabulary to the receiving organization's vocabulary; usually results in imperfect translations because of vocabularies' incompatible levels of detail (examples: e-mail of free text, or PC-based exchange of files in incompatible/proprietary file formats, HL-7 messages). Level 4: Machine-interpretable data—transmission of structured messages containing standardized and coded data; idealized state in which all systems exchange information using the same formats and vocabularies (examples: automated exchange of coded results from an external lab into a provider's EMR, automated exchange of a patient's "problem list").

■ **Software model.** Using Analytica software (version 3.0.1) from Lumina Decision Systems Inc. (Los Gatos, California), we created the analytic model as an influence diagram. This software allowed us to depict complex factor relationships graphically, to consider many factors simultaneously, to incorporate probability distributions to represent uncertainties, and to test the sensitivity of projections to variations in key inputs. Although we cannot include full model specifications in this brief paper, we reference important data sources in each topic area.

■ **Projections of costs.** We projected costs for the interfaces required by each participating organization's computers for communicating with external computers and for internal HIEI-capable systems for providers. To calculate national costs, we allocated relevant costs to relevant organizations. The only exception to this approach was for provider-payer costs, which were taken directly from the Health Insurance Portability and Accountability Act's (HIPAA's) Final Impact Analysis.[4]

Interfaces are programs that enable different systems to communicate with one another. We estimated Level 3 interface development costs based on expert opinion, assigning $50,000 per interface for hospitals, labs, radiology centers, pharmacies, and public health departments, and $20,000 per interface in group-practice offices. Experts were divided on whether Level 3 or Level 4 interfaces would cost more; we assumed that they would cost the same. Level 3 requires a unique interface to each external organization, and we assumed from eight to twenty interfaces per provider, depending on the provider's size. Level 4 HIEI requires one interface to each type of external organization—for example, one interface to all external laboratories, totaling five per provider. For both Level 3 and Level 4, each external organization requires an interface to providers, and we assumed one per laboratory, radiology center, and pharmacy and two per local public health department—one to hospitals and one to office practices.

Relatively few providers currently have broad and mature clinical information systems.[5] Thus, we assumed that all U.S. providers would install new systems, using the Institute of Medicine's (IOM's) definition of minimal functional specifications for the electronic health records that would be required for HIEI Levels 3 and 4.[6] To estimate the national costs of these systems, we applied Christian Birkmeyer's cost estimates to hospital providers and our earlier estimates for advanced ambulatory systems to outpatient providers.[7] Acquisition costs include initial licenses, hardware, implementation, and training. For both interfaces and provider systems, we assigned annual maintenance costs equal to 17.5 percent of the initial acquisition costs to cover ongoing license fees, system upgrades, and hardware replacement costs.

■ **Projections of benefits.** We searched for evidence about information flows between organizations and asked the expert panel to estimate the impact of each level of HIEI on these flows. The model calculated benefits to organizations and to the country as a whole by combining published quantitative evidence, national provider statistics, other data points, and expert-panel estimates of HIEI impact.

As an example, Exhibit 1 illustrates the projection of benefits from Level 4 HIEI between outpatient providers and independent laboratories. As in our other calculations, we asked expert panelists to estimate the impact on participating organizations once they are connected at each HIEI level. To simplify our analysis, we assumed that this was effective 100 percent of the time.

The model first estimates baseline total lab test costs: a combination of fees billed by laboratories and administrative costs incurred by providers in handling the paper and phone calls associated with tests. Then it estimates the proportion of tests (and costs) that are redundant and avoidable with HIEI. For the remaining tests, it estimates the impact of HIEI on the administrative portion of test costs. Finally, the model sums these cost savings and applies them to recent population statistics to calculate national benefit.

■ **National rollout scenario.** To allocate benefits and costs over time, we developed a ten-year national implementation scenario. We assumed that 20 percent of organizations would install systems in each of the first five years, incurring all acquisition and start-up costs in year 1, and maintenance costs in years 1 through 10. We postulated that each organization would accrue 50 percent of potential benefits in year 1, and that benefits would increase by 10 percent each year. We did not attempt to account for inflation, discounting, or changes in utilization from changes in the national population. Therefore, amounts are in 2003 dollars and reflect current care patterns and population figures. Again, provider-payer costs are an exception, as they were amortized over three years to be consistent with HIPAA's Final Impact Analysis.

Results

■ **Costs of HIEI.** Level 2 HIEI is cost-free, as faxing is universally available. Level 3 and

EXHIBIT 1
Example Calculation: Annual National Benefit From Level 4 Health Care Information Exchange And Interoperability (HIEI) Between Outpatient Providers And Independent Laboratories

Item	Amount
A—Lab fee billed per test	$40.00[a]
B—Provider administrative cost incurred per test (included in fee billed for visit)	$19.25[b]
C—Total cost per test to labs and providers (A+B)	$59.25
D—Lab test costs billed per person per year	$86.52[a]
E—Number of lab tests per person per year (D÷A)	2.17
F—Total cost of lab tests per person per year (C×E)	$128.57
G—Avoidable redundancy in testing, estimate one	20%[c]
H—Avoidable redundancy in testing, estimate two	8.6%[d]
I—Average avoidable redundancy in testing (average of G and H)	14.3%
J—Proportion of avoidable redundant tests that could be avoided at Level 4	95%[b]
K—Tests avoided at Level 4 (I×J)	13.7%
L—Tests avoided per person per year (E×K)	0.294
M—Costs saved from avoided tests per person per year (C×L)	$17.41
N—Remaining tests per person per year (E−L)	1.87
O—Proportion of lab test administrative costs that could be avoided at Level 4	95%[b]
P—Provider lab test administrative cost avoided per person per year (B×N×O)	$34.18
Q—Lab administrative cost incurred per test (included in fee billed for test)	$20.40[b]
R—Lab administrative cost avoided per person per year (N×O×Q)	$36.22
S—Total avoided cost per person per year, from avoided tests and avoided administrative costs on remaining tests (M+P+R)	$87.81
T—U.S. population	281,421,906[e]
U—Cost adjustment factor	1.286[f]
V—Annual national benefit of Level 4 HIEI between outpatient providers and laboratories (S×T×U)	$31,800,000,000

SOURCES: See below.

[a] S.J. Wang et al., "A Cost-Benefit Analysis of Electronic Medical Records in Primary Care," *American Journal of Medicine* 114, no. 5 (2003): 397–403.

[b] Expert-panel estimate.

[c] D. Brailer et al., *Moving toward Electronic Health Information Exchange: Interim Report on the Santa Barbara County Data Exchange,* July 2003, www.chcf.org/documents/ihealth/SBCCDEInterimReport.pdf (18 November 2004).

[d] D.W. Bates et al., "What Proportion of Common Diagnostic Tests Appear Redundant?" *American Journal of Medicine* 104, no. 4 (1998): 361–368.

[e] U.S. Census Bureau.

[f] D. Johnston et al., *The Value of Computerized Provider Order Entry in Ambulatory Settings* (Chicago: Health Information Management and Systems Society, 2003), 26. The cost factor adjusts costs—which are largely based on statistics about insured non-Medicare patients—to reflect a population that includes uninsured and Medicare patients.

Level 4 costs are presented in Exhibit 2.

■ **Benefits of HIEI.** Where we could find sufficient evidence, we quantified the benefits of HIEI. In presenting those results, we reference important data sources and describe additional qualitative benefits of HIEI for which we could not develop quantitative estimates.

Both freestanding and hospital-based outpatient clinicians use external laboratories. Interoperability between these organizations would enable computer-assisted reduction of redundant tests, and it would reduce delays and costs associated with paper-based ordering and reporting of results.[8] These savings would produce an annual national benefit of $8.09 billion at Level 2, $18.8 billion at Level 3, and $31.8 billion at Level 4. In addition, provider-laboratory connectivity would give cli-

EXHIBIT 2
National Ten-Year Roll-Out And Annual Costs Of Health Care Information Exchange And Interoperability (HIEI)

	Roll-out cost ($ billions)		Annual cost ($ billions)	
	Level 3	**Level 4**	**Level 3**	**Level 4**
Clinician office system cost	163	163	9.08	9.08
Hospital system cost	27.1	27.1	1.58	1.58
Provider interface cost	124	76.2	9.04	5.40
Stakeholder interface cost	6.41	9.92	0.467	0.467
Total	320	276	20.2	16.5

SOURCE: Authors' analysis.
NOTE: Payers participate in Level 4, making stakeholder interface costs higher than Level 3 during the rollout. Their annual costs are unknown. For explanation of Level 3 and Level 4, see text. All results are stated to three significant digits.

nicians better access to patients' longitudinal test results, eliminate errors associated with reporting results orally, optimize ordering patterns by making information on test costs readily available to clinicians, and make testing more convenient for patients.

Most imaging procedures ordered by office-based clinicians, and some ordered by those in hospital-based ambulatory practices, are performed in external radiology centers. Connectivity between these organizations would reduce redundant tests and would save time and costs associated with paper- and film-based processes.[9] Our model projects annual national savings from avoided tests and improved efficiencies of $8.34 billion at Level 2, $14.4 billion at Level 3, and $26.2 billion at Level 4. Although we did not model additional potential impacts, interoperability here could also improve ordering by giving radiologists access to relevant clinical information, thereby enabling them to recommend optimal testing; improve patient safety by alerting both the provider and the radiologist to test contraindications; facilitate coordination of care and help prevent errors of omission by enabling automated reminders when follow-up studies are indicated; and lessen adverse environmental impacts by reducing the use of chemicals and paper in film processing.

Interoperability between outpatient providers and pharmacies would reduce the number of medication-related phone calls for both clinicians and pharmacists, saving $2.19 billion at Level 2, $2.66 billion at Level 3, and $2.71 billion at Level 4 each year.[10] It would also improve clinical care by facilitating the formation of complete medication lists, thereby reducing duplicate therapy, drug interactions and other adverse drug events, and medication abuse. It could also enable automated refill alerts, offer clinicians easy access to information about whether patients fill prescriptions, and complete insurance forms required for some medications. In addition, it could help identify affected patients in the event of drug recalls, uncover new side effects, and improve formulary management.

Provider-provider connectivity would save time associated with handling chart requests and referrals.[11] The model assumes that all needed charts are requested and projects annual national benefits from these time savings of $2.92 billion at Level 2, $8.11 billion at Level 3, and $13.2 billion at Level 4. Moreover, connectivity would reduce fragmentation of care from scattered records and improve referral processes.

Provider connectivity to the U.S. public health system would make reporting of vital statistics and cases of certain diseases more efficient and complete, potentially saving the nation $63.2 million at Level 2, $107 million at Level 3, and $195 million at Level 4 each year.[12] However, the most important impact of public health interoperability would almost certainly derive from earlier recognition of emerging disease outbreaks and biosurveillance, as it becomes easier to identify warning signs and trends by aggregating data from many sources. Since robust quantitative evidence about the value of HIEI in earlier recognition of disease and biosurveillance does not yet exist, we did not project value from these sources.

Provider-payer transactions enjoy a relatively high degree of standardization, largely because of HIPAA. HIPAA does not allow Level 2 and Level 3 connectivity. Some transactions are highly automated, but others are not, particularly in smaller organizations. We combined recent statistics about electronic transaction rates with estimates of HIEI impact on the nonelectronic transactions. Our model estimates that moving to Level 4 interoperability for all provider-payer transactions would save the nation $20.1 billion each year.[13]

An example at the organization level helps bring perspective to these numbers. A medium-size hospital, defined in our analysis as one with 50–199 beds, would invest $2.7 million in clinical systems and interfaces to achieve Level 4 interoperability. Beginning in year 2, it would spend $250,000 per year to maintain those systems. Benefits would increase over time as the hospital moved up its "learning curve" and as more of its care partners were connected. Once it reached its steady state, it would accrue benefits of $1.3 million annually, from its transactions with other providers ($570,000), laboratories ($200,000), radiology centers ($170,000), payers ($250,000), and pharmacies ($70,000). Since hospitals provide in-house services for most laboratory and radiology tests, their greatest need for—and benefit from—external information exchange is with other providers.

■ **Net value of HIEI.** Combining the benefits and costs quantified above, we present the net value of three different levels of HIEI in Exhibit 3.

Each year in the Level 4 steady state, providers benefit from connectivity with other providers ($12.2 billion), radiology centers ($8.82 billion), payers ($10.3 billion), and laboratories ($13.9 billion). Providers lose money from connectivity to pharmacies (–$0.037 billion) and public health departments (–$0.98 billion), effectively subsidizing those connections, and they incur annual costs of $10.5 billion to run the systems required, leaving them with an annual net value of $33.7 billion. Payers realize net value from improved efficiency of provider transactions ($9.84 billion), and from avoided lab ($3.76 billion) and radi-

EXHIBIT 3
Net Value Of Health Care Information Exchange And Interoperability (HIEI)

	Implementation, cumulative years 1–10 ($ billions)	Steady state, annual starting year 11 ($ billions)
Level 2		
Benefit	141	21.6
Cost	0.0	0.0
Net value	141	21.6
Level 3		
Benefit	286	44.0
Cost	320	20.2
Net value	–34.2	23.9
Level 4		
Benefit	613	94.3
Cost	276	16.5
Net value	337	77.8

SOURCE: Authors' analysis.
NOTES: For explanation of levels, see text. All results are stated to three significant digits.

ology ($8.04 billion) tests. Other organizations realize net value from improved efficiency of provider transactions (laboratories, $13.1 billion; radiology centers, $8.17 billion; pharmacies, $1.29 billion; and public health departments, $0.094 billion). The total annual net value to these stakeholders is $77.8 billion (rounded).

We measured the sensitivity of net value to variations of 50 percent in model inputs. Results are most sensitive to the average costs of laboratory tests and radiology procedures, with 50 percent decreases in those averages reducing annual Level 4 net value to $68.7 billion and $72.2 billion, respectively. Inflating the average cost by 50 percent raises annual net value to $105 billion for more expensive laboratory tests, and to $94.6 billion with more expensive radiology procedures. Given the unexpected pitfalls that accompany large systems installations, we also tested a less favorable cost scenario. Doubling the systems and interface costs reduces annual net value to $61.3 billion. To test the potential impact of reduced technology costs, we halved the systems and interface costs and calculated an annual projected net value of $86.1 billion.

Discussion

Based on our analysis of those elements of interoperability for which we can assign dollar values, net savings from national implementation of fully standardized interoperability between providers and five other types of organizations could yield $77.8 billion annually, or approximately 5 percent of the projected $1.661 trillion spent on U.S. health care in 2003.[14] In addition, the model did not quantify many potentially important costs and benefits. On balance, we believe that their net value is largely positive; the value of fully standardized interoperability is likely to be higher than our quantified results suggest. Overall, we believe that a compelling business case exists for national implementation of fully standardized HIEI.

We suspect that the clinical payoff in improved patient safety and quality of care could dwarf the financial benefits projected from our model, which are derived from redundancies that are avoided and administrative time saved. Giving clinicians access to data about their patients' care from providers outside their organizations would likely result in fewer medical errors and better continuity of care. But electronic exchange of clinical data between organizations is nascent, and few data exist about the clinical impact it would bring. It will be important for future inquiries to explore such impact in depth.

Both Level 2 and Level 3 nonstandardized electronic communication offer positive financial returns, although they pale in comparison with the value of fully standardized interoperability. The most basic form of electronic interoperability—Level 2 faxing—is already universally available (and therefore nearly cost free) and could offer immediate reductions in the time spent on many transactions if it were more widely used.

Level 3 interoperability requires a hefty investment in interfaces to translate heterogeneous electronic vocabularies, although it eventually accumulates benefits that outweigh those costs. However, it is not realistic for the nation as a whole to plan to "step up" over time, hoping for an orderly progression from nonstandardized Level 3 to standardized Level 4 interoperability, as national standards are gradually adopted. Level 3 HIEI requires that organizations develop interfaces to others' coding schemes, an investment that locks in local solutions, diverts resources from developing more-universal approaches, delays conversion to national standards, and guarantees additional costs down the road to convert to national standards once they exist.

With national standards today neither completely defined nor adopted, it is tempting to develop a nonstandardized Level 3 system. Level 3 systems can indeed aggregate information from remote sources. However, they must reconcile diverse codes, data structures, and terminologies. Through such inevitably imprecise processes, Level 3 systems may generate errors and redundant information, limit the efficacy of clinical decision support, and create information and cognitive overload for clinicians. A Level 4 system, with on-demand, seamless integration of local and remote records, is far more likely to offer clinicians the integrated information they need for providing optimal care.

If one considers the difference between Levels 3 and 4 to be the value of national standards, they could be worth billions of dollars. We did not estimate the cost of developing such standards, but it seems reasonable to assume that it would be in the millions, rather than billions, making development of coherent, universal standards a sound investment.

■ **Limitations.** Our analysis is limited in several important ways. Beyond transactions with payers, health care organizations have little real-world experience with electronic information exchange and almost no experience with transactions that bear on clinical matters. Our analysis incorporates the best quantitative evidence available from a small number of studies, but we had to rely on expert estimates more often than would be optimal. We were also not able to impute values for clinical or organizational effects of HIEI or for probable societal impacts, such as faster detection of disease outbreaks, other improvements in biosurveillance, and broad impacts on workflow based on electronic rather than paper information. HIEI could affect these health care processes in powerful ways, well beyond the individual patient-clinician encounter.

In addition, the model did not account for lost revenues from avoided tests and other changes in utilization, or for the cost of major workflow disruptions during systems implementation. If employees are redeployed, the financial benefits projected from time savings may be realized as improved productivity or service quality, rather than pocketed dollar savings, and the model did not distinguish between these endpoints.

Finally, although we included costs for providers' and payers' HIEI-capable systems, we did not account for corresponding costs to laboratories, radiology centers, pharmacies, and public health departments. Such an undertaking would include collecting sensitive—and sometimes proprietary—data about very complex systems from heterogeneous organizations, an effort beyond the scope of this project. For these entities, we assumed that these costs are subsumed in the costs of doing business. In spite of these limitations, our confidence in our model is bolstered by the results of multiple sensitivity analyses that found that the findings are not materially affected when we vary important inputs.

■ **Policy considerations.** Although it is beyond the scope of this paper to speculate in depth about who would benefit from HIEI, patients and providers most likely have the most to gain. Organizations such as regulatory agencies, research institutions, and others not considered here could benefit from aggregate information about care. However, those who depend in subtle ways on redundancy and excess could find such change costly.

National HIEI may well grow from regional data-sharing initiatives. If incentives can be established to encourage these local efforts, and national standards can be established for them to adopt from the start, these networks may one day be knit together into a seamless, national Level 4 health care information system, although this will not occur without some federal leadership. Achieving Level 3 and Level 4 interoperability will require sizable investment in HIEI systems by providers and stakeholders. Participants realize different levels of return on HIEI investments, and the conflicting financial incentives of the health care system raise complex policy questions about who should pay for development and implementation.[15]

Thus, achieving Level 4 interoperability will require strong policy incentives, federal leadership, and possibly state and federal legislative mandates.[16] At a time of national tumult over quality, safety, and cost, achieving seamless interoperability among vital sectors of the delivery system must proceed in parallel with the move from paper to EMRs. Both will be enormously valuable, and they will be synergistic. Creating an environment that encourages this transformation represents an opportunity that must be seized.

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