

The Effects of Health Information Technology on Inpatient Care

THE COSTS OF HEALTH CARE IN THE UNITED States are the highest of any country in the world, and they are rapidly becoming unsustainable, affecting the costs of goods and services made in our economy, which is suffering. This is especially problematic since the quality and safety of care nationally is mediocre or worse—the United States actually ranked last among the industrialized nations evaluated in one recent study using preventable mortality as an outcome.¹ This has led to intense interest in approaches to improve quality and safety and reduce costs, and increased use of health information technology (HIT) has emerged as one of the key tools for addressing these issues,² with one study estimating the potential savings over 10 years of increased HIT adoption broadly to be \$88 billion, although other studies have reached much higher point estimates.^{3,4}

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However, HIT is expensive, and there have been serious doubts about the extent to which it will actually be beneficial. In this environment, the nation's hospitals have had to make decisions about whether and to what extent to invest in HIT, at a time when many of them are losing money and are strapped for capital. The net result has been that organizations have been nervous about making large investments in technology that is difficult to implement, creates major issues with change management, carries a substantial risk of failure, and has uncertain benefits.

A closer examination of the evidence regarding the impact of HIT reveals that much of it comes from 2 levels: single-institution studies mostly focusing on limited outcomes such as serious medication error rates or turnaround times^{5,6} or economic models that are much more comprehensive but rely on projections^{3,4} and incorporate many expert judgments even for factors that are important. The single-institution studies have largely been positive, but most have had fairly modest scope, with a few exceptions; for example, a landmark study done by Tierney et al⁷ evaluating the economic impact of implementing computerized physician order entry found that costs per admission fell \$887 and length of stay decreased 0.89 days. The models have consistently projected large benefits for HIT; for example, Walker et al³ projected an annual savings to the United States of \$78 billion annually for clinical data exchange when it has reached a steady state, and Hillestad et al⁴ projected an annual savings of \$84 billion

for implementation of electronic medical records and networking. However, many have been skeptical of the evidence, broadly regarding the economic benefits of HIT and these projections in particular. Notably, the Congressional Budget Office (CBO) reviewed the available evidence on the benefits of HIT and regarding the 2 models in particular concluded that “the bottom line is that both these studies appear to significantly overstate the savings to the health care system as a whole . . . that would occur from legislative proposals to bring about widespread adoption of health IT.”^{8(p8)} A key concern of the CBO evaluation was that these studies did not assess the “likely” benefits but instead targeted the potential benefits in a best-case scenario.

A noticeable lack has been studies that get at the area between these 2 levels—studies that begin to assess the benefits of HIT adoption across multiple institutions, as it is routinely used, and cover a broad range of outcomes. The reports to date that have addressed this have mostly been more management oriented than scientific; for example, one study found that “most-wired” hospitals⁹ performed better across a number of quality measures than comparison hospitals. There are clearly confounders here—“most-wired” hospitals tend to be better off. However, the difference in performance, though statistically significant, was modest (in the 2%-7% range), and the “most-wired” hospitals were far from perfection, with performance for most measures in the 80% to 90% range. In another recent study that addressed this issue, Jha et al¹⁰ found that hospitals with computerized physician order entry had lower 30-day mortality rates for myocardial infarction and pneumonia.

NEW CONTRIBUTIONS

Thus, in this issue of *Archives*, the study by Amarasingham et al¹¹ that assesses the relationship between HIT and both costs and clinical outcomes in hospitals in Texas provides extremely important additional information and represents a landmark in this area. In this study, Amarasingham et al¹¹ evaluated whether increased automation of hospital information was associated with decreased mortality, complication rates, and costs and length of stay. Notably, they used a tool called the Clinical Information Technology Assessment Tool (CITAT) to assess how physicians interacted with the information system and did not just assess whether technologies were present or absent. This is especially important because the best information technology application in the world is of no value if it is not clinically used, and to derive ben-

efit, what is important is not the application itself but the interaction between the technology and its routine use in actual clinical care. They were also able to determine what technologies were present at each site.

Amarasingham et al¹¹ found impressive relationships between the presence of several technologies and complication and mortality rates and lower costs. The specific technologies evaluated included order entry, clinical decision support, and automated notes. For example, higher order entry scores were associated with 9% and 55% decreases in mortality rate for patients with myocardial infarction and coronary artery bypass surgery, respectively. The results for decision support were impressive: higher decision support scores were associated with a 21% decrease in the risk of complications. Perhaps of most interest from the informatics perspective was the impact of automated notes, which were associated with a 15% decrease in the risk of fatal hospitalizations among all causes. Of these 3 technologies, although it does not always go in this order, hospitals tend to implement order entry first, with limited decision support, and then add decision support and then automated documentation. The latter is especially hard to implement, and the benefits have been uncertain, although it stands to reason that just being able to read all the notes and find them readily might have major benefits. This benefit may well increase much further as search tools become more readily available within electronic records.

Of course, merely demonstrating that associations were present does not mean that the associations were causal. Hospitals that have more HIT tend to have more resources and probably have better performance with respect to quality to begin with. However, Amarasingham et al¹¹ have controlled for potential confounders as well as is possible, and a large number of impressive relationships persisted. Furthermore, the issue of multiple comparisons is an important one, though the authors have considered it and made appropriate corrections. However, a quick review of the results tables will demonstrate that benefits were found for only some of the outcomes, though for many there were nonsignificant trends. There were also some instances in which relationships in the opposite direction were found; for example, electronic documentation was associated with a 35% increase in the risk of complications in patients with heart failure, though this may have been present because it was easier to find these events since better documentation was present.

Thus, the level of evidence in the article by Amarasingham et al¹¹ should be considered circumstantial; there is no way to be certain that the HIT is responsible for the changes observed. Then again, we will never get randomized controlled trials of technologies such as physician order entry across multiple institutions—it is far too complex, takes too long to implement, and is too expensive. The net is that this type of evaluation is the best we can expect. Clearly, though, additional evaluations should be done.

So what does this study add to the existing literature? First, it points out that across a large number of hospitals with mostly commercial implementations of HIT, there were important relationships between better quality and safety and lower costs. These data thus represent an important “bridge” between the data from single-

institution studies and models. Second, the use of the CITAT instrument to measure how the information technology was actually being used in the hospitals is likely pivotal. It is not sufficient just to have bought the technology—it has to be used effectively in a much broader quality structure. When it is not used effectively, it may even worsen performance. In one study, after implementation of computer order entry, a 3-fold increase in mortality was identified in children transported in for special care.¹² However, in another study using exactly the same vendor in a children's hospital, but with a much different implementation strategy, a 36% reduction in the standardized mortality was identified for all patients in their pediatric intensive care unit,¹³ although this difference was not statistically significant.

THE POLICY PERSPECTIVE

How best to measure the difference between simply having a technology and assessing how it is being used represents an important issue from the policy perspective because there is great interest in providing incentives to organizations that implement HIT, but simply incentivizing use may not be sufficient. While many have argued for solely incentivizing outcomes, that may be problematic as well, since many now believe that it is essential to implement the technology and then work on how best to use it and, for an interval, outcomes may even worsen. A staged approach may be the most effective, first incentivizing use and then gradually raising the bar.

Another trend that should be noted is that hospitals are beginning to routinely measure care and are asked to make their results public for many measures.¹⁴ To perform well across a large number of measures, it will be essential to have many of these functions, especially order entry, in place because order entry can be used to prompt health care providers about following guidelines and using checklists, as well as to measure performance and iteratively improve it. Quality improvement and information systems are coming closer together, and the groups responsible for these areas in hospitals have to interact effectively if success is to be achieved.

Thus, we are left with a number of important questions. First, are the technologies—computer order entry, decision support, and clinical documentation—sufficiently mature that hospitals should be adopting them now? My own view is that the answer is a clear yes for computer order entry and decision support for large hospitals.^{10,15} For smaller hospitals, which use a different set of vendors, the answer is less clear, but studies are currently under way that should provide additional information regarding this. For clinical documentation, the benefits are still only beginning to be determined and are likely to be spread across a wide range of areas, but this will likely prove to be beneficial as well.

Another question is whether the negative consequences of implementing HIT in hospitals overwhelm or wash out the positive ones, as some have suggested.^{16,17} The article by Amarasingham et al¹¹ provides additional evidence that they do not overall, although those who have emphasized the unintended consequences have made many valuable points about the importance of evaluating any new

technology after implementation and making multiple changes to it—points that are all too often ignored.

Another hotly debated issue has been the question of whether the results in hospitals using vendor applications will be as good as those seen in a few hospitals that have developed their own homegrown systems.¹⁸ While the article by Amarasingham et al¹¹ does not answer the question of whether the results will be the same, it does suggest that they will be substantial in hospitals using vendor applications.

At the end of the day, does this article mean that hospitals should now climb on the HIT bandwagon? The data are too circumstantial to answer this definitively, but they provide another extremely important set of results. More of such analyses should be done, and they are likely to be helpful in convincing policy experts including skeptics like those at the CBO of the benefits when these technologies are in routine use. For large- and medium-sized hospitals, it appears that the time is now. This article by Amarasingham et al¹¹ also provides some of the first evidence about the benefits of computerizing clinical documentation, which should be high on the “to do” list of organizations.

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