improve-it-institute.org

indices to measure performance relating outcomes, value, & expenditure from information technology

Does Measurement Improve Performance?

Results from the First IMPROVE-IT Conference

Kevin Leonard, MBA, Ph.D., CMA
Associate Professor, Department of Health Policy, Management and Evaluation
Faculty of Medicine, University of Toronto
12 Queens Park Crescent West,
2nd Floor, McMurrich Building
Toronto, Ontario M5S 1A8
CANADA
W: 416-464-7885

Dean F. Sittig, Ph.D.,
Director, Applied Research in Medical Informatics
Kaiser Permanente
3800 N. Interstate Ave. (CHR@WIN)
Portland, OR 97227
U.S.A.
W: 503-335-6316

Background

The IMPROVE-IT Institute is a collaborative research initiative that attempts to provide the evidence that increased IT capabilities, availability, and use leads directly to improved clinical quality, safety, and effectiveness with an emphasis on the inpatient hospital setting. For specific consideration, we have defined measurement indicators in three areas:

1. IT spending (both initial and on-going investment),
2. technology infusion (i.e., system availability, adoption and deployment), and
3. health outcomes (e.g., clinical efficacy, efficiency, quality, and effectiveness).

It is our objective to demonstrate the link between improved information technology performance and increased effectiveness across a number of health outcomes through the generation of overall performance measurement indices. These indices will be used to create a framework of benchmarks and comparisons so as to generate a repository of evidence and best practice. IMPROVE-IT will perform both routine descriptive as well as advanced predictive statistical analysis in order to generate and distribute regular reports to subscribers.

Introduction

To date, there has been little evidence in the literature showing that spending on healthcare IT leads to greater system availability, increased clinician use, improved decision-making, or better health outcomes. Recent literature has discussed measuring the value that is associated with information and communication technology (for example, Leonard, 1998; Leonard, 2004). One of the main reasons that health care systems have not widely adopted information technology is that the benefits from investment in IT are poorly defined (Leonard, 2000; Kuhn and Giuse, 2001). Research needs to develop better methods for tracking IT spending, system availability, and utilization. Recent studies have attempted to estimate the business value generated from IT investment in healthcare in specific areas, but they have not recommended any method for measuring a broader (e.g., hospital-wide) effect or for dealing with the problems of partial implementation (see Rosenstein, 1999; Frisse, 1999; Agrawal , 2002; Kuperman, 2003; Wang, 2003).

In contrast to these prior efforts, our project will develop several measures that link clinical system availability, use, and cost to clinical impact over a wide range of healthcare scenarios, clinical conditions, and institutions. IMPROVE-IT aims to demonstrate the relationship between information and communications technology and better health outcomes and to measure which factors affect whether a particular IT investment is successful.

First Conference in Toronto November 11-12, 2004.

The first step in our Research Plan was to host a conference that would bring together people from a wide variety of stakeholder groups. In order to define the metrics, we needed to generate a consensus from many perspectives as to what was important to measure and how the measures should be calculated. On an ongoing basis, it is envisioned that these metrics would evolve and become much more comprehensive and complex however it is critical that the early stage metrics be meaningful and feasibly generated from data that was clear, concise and accessible.

The objective of the first day was to illustrate that many lessons could be learned from the investment that has been made to date in healthcare. Unfortunately, we have not found an easy way of documenting this experience so that hospitals (as well as other health service providers) can access this "experience and knowledge" efficiently. As a result, the healthcare field continually builds information systems for "the first time". In companies and organizations within other industries, experience grows over time when the subsequent generation of systems are developed. In healthcare, due to its late start, there is very little longitudinal history. Therefore, much of our experience must come from other organizations within healthcare that are designing or implementing similar systems. But this sharing is not happening! This is due to the fact that many systems implementation are fraught with many failures, and people associated with these lessons are reluctant to have that information publicized. What must be emphasized is that this was the case with many other industries as well – failures within the realm IT implementation are NOT unique to healthcare! IMPROVE-IT believes that this "experience sharing" can best be done through ***objective measurement*** with the emphasis on lessons learned and not on laying blame.

Consequently, the first day was spent discussing failures across the stakeholder groups. As is illustrated in the Day One Agenda (see below), we had input from researchers, hospitals, integrated regions, consulting companies, vendors and community care agencies. These presentations demonstrated first hand the strategy and the implementation of many information systems initiatives throughout North America. Each of these perspectives brought some "soul-searching" and "lessons learned" as every one of the initiatives had significant hurdles to overcome.

These presentations clearly led into a discussion around measurement and how difficult this is and how infrequently it is accomplished. Part of this is due to the nature of measurement that is seen as more of a management function than a task function. In a world where most of us are working harder, it is tough to get people to stop and begin to think about working smarter. This work smart program requires measurement and an understanding of what is working well and what is not. Secondly, of course, is that measurement requires a clear understanding of what it is you can measure and how that relates to what it is your managing!

Agenda – Day One

Title: The Global eHealth Initiative –Learning from ventures worldwide
Presenter: Alex Jadad, Center for Global eHealth Innovation, University Health Network, Toronto

Title: Failures and Successes: How they have changed us
Presenter: Tom Rosenal, Calgary Health Region, Calgary, Alberta

Title: The Success-Failure Profile: Predicting Success or Failure with Clinical Computer Innovation
Presenter: Janis Smith, Vanderbilt University Hospital, Nashville, Tennessee

Title: A Global Perspective on Lessons Learned, Change and the Need for Measurement -
Presenter: Dean Sittig, Kaiser Permanente, Portland, Oregon

Title: Can we learn from what happened? Creating Agents for Change
Presenter: Glen Geiger, Sunnybrook and Women's College Hospital, Toronto, Ontario
Dominic Covvey, University of Waterloo, Waterloo, Ontario
Dan Gordon, Praxia Consulting, Toronto, Ontario

Title: The Community Care Experience – Different Approaches
Presenter: Camille Orridge, Toronto Community Care Access Center, Toronto, Ontario
Tina Mah-Sanscartier, Waterloo Region Community Care Access Center, Waterloo, Ontario

Title: A technology vendor's experience
Presenter: David Lewis, Dataglider Inc., Richmond Hill, Ontario

---

The second day of the conference focused on measurement with two presentations emphasizing the relationship between strategy and measurement. These two talks highlighted the need to define strategy and then implement a measurement and evaluation plan that reinforces that specific strategy. Then, post implementation, the metrics can outline in detail both the successes and the failures.

Finally, the conference ended with the remainder of Day Two Agenda (see below) placing the participants into breakout groups and working on defining the indicators that we will begin to track.

In the project, member hospitals will be asked to provide measures on their hospital's performance each quarter over the 3 year project to a secured website. In exchange for this commitment, only member hospitals will be provided access to the secured website and all of the reported results (prior to publication). These results will be generated quarterly and will present performance measures and comparisons of individual member hospital to an average "benchmark" as well as to other unidentified peer group hospitals.

Day Two **Let's begin the measurement**

Title: Health System Accountability through Performance Measurement - An Alberta Example
Presenter: Shaukat Moloo, Alberta Health & Wellness, Edmonton, Alberta

Title: Using information and technology in the measurement and evaluation
Presenter: Michael Carter, Mechanical & Industrial Engineering, Univ of Toronto, Toronto

Breakout session 1 - Identifying cost indicators
Breakout session 2 - Identifying infusion indicators
Breakout session 3 - Identifying outcome indicators

Conference Findings – *IT Investment*

It is hypothesized that IT investment provides an environment for a new and comprehensive level of care to exist. That is, without new technology and better information, clinicians would not be able to deliver the effective care that they can when these types of investment are made. IT can provide an opportunity to assess trends that formerly have taken much longer to identify. Improved information access can lead to rapid decision-making relating to that information. Often, a decision support tool is a component of the new system. Decisions aided by this support system may improve the operation of the organization: actions can now be taken sooner than they were taken historically, if they were taken at all. Finally, the IT can be used to evaluate its own effectiveness by providing information on the improvement across a wide range of indicators.

In short, better information can lead to better care, as demonstrated by improved health outcomes. Some outcomes emanating from better information are fewer duplicated tests, a faster turnaround in accessing reports and other patient information, and better management through trend analysis. Better health outcomes may also include:

- diagnosing patients more accurately, as well as sooner
- complying with patients' wishes and comforting the family
- reducing the number or severity of errors
- supporting care delivery through better access to information

Although capturing and documenting IT investment may appear to be clear-cut, there is much subjectivity around the boundaries of IT and what should or should not be included. Some of these include:

1. Hardware - PCs, servers, printers, portable devices (and the amortization)
2. Clinical Information System - software (initial purchase and annual maintenance)
3. IT personnel required to keep system functioning - help desk, hardware configuration, data base administrators and the like
4. Training costs (initial and ongoing) – people, time off for clinicians
5. Computing infrastructure – networks, routers, cabling, wiring for terminal placement
6. Personnel (non-IT) who spend time either entering data or producing reports and other forms of information and decision support.

It is only once we have decided how to measure these costs can we begin to accurately compare IT implementation and maintenance costs across healthcare delivery systems.

For the first breakout session we charged the group with identifying three measures, indicators, or proxies for the amount of financial resources that an organization puts toward creating the information and communications technology (ICT) infrastructure. After small group discussions, the groups came back together to report on their findings.

The general consensus of the groups was that Information Technology costs could be divided into six basic categories:

1. **Hardware** – all of the equipment necessary for data input, processing, communication, and archiving (e.g., personal computers, servers, routers, network cabling or wireless access points, and storage devices, etc.). One should also factor in the equipment necessary to insure system reliability including battery backup systems, off-site data storage and fail over systems, and even on-site emergency power generators. This equipment could be purchased, rented, or leased. These costs should include both the initial purchase price, the expected amortization period (usually 3-5 years) and depreciation costs.
2. **Software** – all of the software required to keep the organization functioning. This should include both system software such as the operating systems, database management systems, network operating systems, data communication software and compilers (in the event that the organization is developing their own applications) along with the application software such as the results review, provider order entry, clinical documentation, admit/discharge/transfer, registration, scheduling, billing, etc. This software may be purchased, rented, or leased. These costs should include the initial purchase price or development costs, as well as, on-going maintenance contracts or costs (often 1/3 of the original purchase or development costs).
3. **Personnel** – represents all of the people (both central – assuming a local hospital is part of a larger organization, and local) required to keep the systems working including: management, developers, implementers, technicians, and those charged with system and application maintenance. In addition, one should factor in the costs of the people charged with providing initial training (both the cost of the trainers as well as the time spent by the students away from their jobs) and on-going support to the clinicians (e.g., help desk operators). An initial estimate of this number could be the number of Full-Time Equivalents (FTEs) in the information technology department along with an average cost associated with FTE's in your organization.
4. **Space** – this number should reflect the costs to purchase, maintain, and manage the space or real estate required to house all of the personnel and equipment associated with the ICT department. In addition to the purchase price, rent, or leasing fees and their associated amortization and depreciation costs, one should also factor in the costs of providing heat, light, and cleaning services within these areas. An initial estimate of this number could be the total number of square meters taken up by the ICT department. Clearly this number will depend greatly on whether this space in located within the hospital or at an off-site location. It will also vary depending on the use of the space, for example, space for personnel probably costs significantly more than the space required to store backup disks or tapes.
5. **Consumables** – these are the items such as computer disks, paper, printer cartridges, etc. which are consumed the ICT organization. While often considered a small part of the total ICT costs, a general rule of thumb is that the yearly cost of a printer for depreciation and maintenance (which are not consumable items), and paper and printer cartridges is roughly equivalent to the original purchase price. As a first estimate of the total cost of providing ICT support, the costs of consumables can probably be neglected.
6. **Overhead** – this category is for such items as financial and personnel management, telephone and mail services, etc. As a first estimate, we could probably assign a certain percentage of the overhead costs based on the total number of FTE's in the organization, therefore, this number could be folded into the personnel costs.

Several of the groups cautioned that any measures developed should be capable of taking into consideration at least the following three main methods an organization might use to obtain its ICT solutions: buy it from vendors; build it themselves; or outsource the work. In each of these three modes, one would expect that some of the cost categories would increase while others would decrease. For example, if you buy a system from a vendor, your software costs should be higher, but your personnel costs would consequently be lower. Likewise, if you outsource your work, then you would expect to see significantly lower costs associated with space and personnel, with the consultant and maintenance budget then being considerably higher.

IT Investment Measures

One interesting debate without the groups focused around whether the cost indicators should be just that, an indicator, or should it be an all-inclusive cost calculation, similar to a balance sheet item. In the end, the agreement was to focus on the former for two reasons. First, a simple straightforward indicator will be easier to calculate which will entice more members to submit their findings. Secondly, and perhaps more importantly, our emphasis is to identify a statistical relationship between IT spending and changes in health outcomes. As such, the actual amount invested is not as important as an indicator that can be considered as a predictor – not only of overall spending, but hopefully of changes in outcomes.

After further deliberation, the following metrics have been selected as the first generation of indicators along the cost dimension.

The first measure deals with current ongoing investment in hardware. This indicator is straightforward: **amount of money spent on new IT hardware this quarter.** It is hoped that this indicator will reflect the commitment to investing in new technology.

The second investment measure will incorporate the human resources needed to operate and managed the new technology: **total number of people in IT staff – FTE's.** Once again, this indicator will provide insight into the amount of support required.

The final investment indicator relates to the length of time that there has been a commitment to new technology. This is represented by: **percentage of depreciation to assets.** The logic is that the higher the depreciation, the more the assets have been in service and as such, the longer there has been a financial investment to IT.

Conference Findings – *IT Infusion*

Much of the current IT research literature, and in practice, has been focused on measuring and determining the optimal hardware and software configuration. What the industry truly needs, however, is analysis focused on the *use* of these computerized information systems and how they can provide organization-wide benefits. The adoption of new information technology in the healthcare industry involves more than hardware and software issues. We need the ability to accurately measure the degree of "infusion," or system capabilities, availability and use of various clinical information system features, so that we can begin comparing CIS implementations from different vendors at different organizations. While others (Peel, 1997) have developed very technically oriented measures, we believe that we need to go beyond technical attributes and focus on the behavior of clinicians to really answer, "how integrated (infused) is the technology?"

This is not as straightforward a calculation as it might appear at first glance. Many subjective decisions are made independently by hospitals and other providers before any data are captured or analysis produced. These subjective decisions, which relate to what to capture, how to calculate it, and how to make the analysis relevant, all affect the final product. Due to the complexity of the concept of infusion, there are numerous options and metric calculations that can be selected. If two organizations make a different decision, which is almost a certainty, even if they happen to call the measure by the same name, the possibility is very low that they will then compare identical factors. As a result, a cooperative venture is a necessary condition for meaningful comparisons. Once these measures have been agreed upon, then and only then, can standards and baseline benchmarks be employed industry wide.

Tables 1 and 2 present a snapshot of potential clinical information system infusion metrics and some of the inherent complexities, including the subjectivity of measurement. Although, we anticipate that infusion measures will increase in sophistication during the course of the IMPROVE-IT research network development, those proposed below are a valid starting point.

Table 1: Basic features of a clinical information system (From HL-7 Functionality Specification)

Number	Function Name
1	Capture Patient Demographics
2	Manage Problem List
3	Manage Medication List
4	Manage Allergy List
5	Manage Patient History
6	Clinical laboratory, radiology, EKG, procedure report – results review (1/2 point for 1 year, 1 point for > 1 year of data available)
7	Review chart summary
8	Capture and creation of clinical documents and notes by MDs and/or RNs
9	Enable medication ordering
10	Enable ordering of diagnostic tests
11	Enable placing of other orders
12	Support for referral orders
13	Ability to review radiographs online – PACS
14	Communication with Medical Devices

Table 2: Levels of Clinical Information System Infusion

Item	Definition	Score range	Level 1	Level 2	Level 3	Level 4
1	Basic types of clinical decision support	0 - 6	15 – 30% (1/6)	31 - 50% (2/6)	51 - 65% (3/6)	> 65% (4/6)
2	Basic features if a clinical info system	0-14	25 – 40% (4/14)	41 - 55% (6/14)	56 - 70% (8/14)	> 70% (10/14)
3	% clinics/units with CPOE availability	0-100%	10 – 25%	26 - 50%	51 - 75%	> 75%
4	% of orders entered by providers	0-100%	10 – 25%	26 - 50%	51 - 75%	> 75%
5	% uptime of CIS	0-100%	90 – 93%	94 - 96%	96 - 99%	> 99%
6	% of inpatient rooms or outpatient rooms with a computer	0-100%	0 – 24%	25 – 49%	50 – 74%	> 75%
7	% of all clinicians who use the system on a weekly basis (login)	0-100%	20 - 40%	41 - 60%	61 - 80%	> 80%
8	Workflow integration tools:	0-7				
9	CIS is primary data source: % of visits for which the CIS is used	0-100%	0 – 24%	25 – 49%	50 – 74%	> 75%
10	% of clinical decision support alerts accepted	0-100%	0 – 10%	11 - 25%	26 - 50%	> 50%
11	% of patients with an allergy documented or “no known allergies”	0-100%	15 – 29%	30 - 44%	45 - 59%	> 60%
Total	Total score is the average of all columns					

In the second break out session, we charged the group with identifying three measures for the availability and use of the clinical information and communications technology (ICT) infrastructure. After a 30-40 minute discussion the groups came back together to report on their findings.

The general consensus of the groups was that ***availability*** and ***use*** of Information Technology are two distinct concepts and therefore, we should identify three measures for **each** of these two separate concepts.

IT Availability Measures

To measure **availability** most people thought that we should have a count: **number of clinical applications that are available to 50% or more of the clinicians in an organization**. We define the term "available" to be interpreted as clinicians "have a login that allows them to access that part of the system" as a proxy. Examples of the types of clinical applications that we considered to be key components included:

- Computer-based Provider Order Entry – CPOE
- Computer-based Order Communication
- MD-level admitting, discharge and daily progress notes
- RN-level nurse charting
- Clinical Laboratory Results Review
- Picture Archiving and Communication Systems (PACS)
- Admit / Discharge / Transfer systems
- Clinical data warehouse
- Scheduling
- Billing
- Patient Registration.

Various types of clinical decision support (based on the Clinical Decision Support Implementers' Workbook available at: http://www.himss.org/asp/cds_workbook.asp)

- Proactive Order sets
- Preventive health maintenance reminders
- Drug ordering alerts – drug-drug interactions; drug-allergy; duplicate therapy
- Access to on-line reference materials
- Condition- or order-specific data displays
- Support for complex clinical guidelines, protocols, or pathways

The second availability measure centered on the percentage of the time that the clinical information system was "available for use" by clinicians. We termed this: **system uptime**. It should be calculated as:

% uptime = 100 x (Total time – scheduled downtime – unscheduled downtime) / Total time

Where:

- Total time is the total number of minutes in a day times the number of days over which the measure is taken
- Scheduled downtime includes all scheduled reasons for system unavailability including system upgrades, routine hardware maintenance, system backups, etc.
- Unscheduled downtime includes all unscheduled reasons for system unavailability including power outages, equipment failures, software lock-ups, etc.

The third availability measure we considered was: **total number of unique patients with some type of clinical data available in the clinical repository**. If possible, it would be better to factor in the number of years of data that each of these patients has available which would allow us to calculate an availability measure of the total number of patient-years of clinical data available to clinicians. Another relatively simple proxy for this measurement could be the amount of disk space taken up by the clinical data contained in all the clinical systems. In the end, a simple count of unique patients was selected.

ICT Use Measures

The first clinical information system **use** measure we decided upon was: **percentage of clinicians with an active user-ID / password combination who actually login to the system more than 1 time each day**. We considered several other methods of "normalizing" the number of user logins including: number of logins / occupied bed and mean number of unique logins / individual patient. Once this measure reaches a uniformly high level, that is the vast majority of institutions have well over 90% of their clinicians logging in each week, then we would consider revising this measure to reflect the mean percentage of all clinical applications available to each clinician that the clinician actually utilizes during the week, or month.

For the second use measure we chose to focus on the "timeliness" of the use of the system. While we all agreed on the concept here, we had some difficulty identifying the most appropriate measure in this area. In the end we selected: **percentage of patients with a completed chart (as defined by all data needed entered and signed by all the appropriate clinicians) within 24 hours of their hospital discharge or outpatient visit**.

For the final use measure we focused on several application-specific use measures. Here the goal would be to add one or more of these measures each year as our focus on the key clinical applications changes over time. Currently, there is tremendous emphasis on the use of computer-based provider order entry to reduce the number of errors in the ordering process, therefore we chose: **percentage of all orders entered directly by the patient's primary care provider** (who could be a M.D., physician's assistant, nurse practitioner, and the like). In subsequent years we could easily imagine including, for example:

- Percentage of patient's with a login to their personal health record who actually logged on in a given month, or
- Percentage of clinicians who dictate their clinical notes (which currently requires the additional step of human transcription) rather than enter them directly via the keyboard, or
- Overall percentage of clinical alerts or reminders that are overridden by clinicians.

Conference Findings – *Health Outcomes*

State of the art information and communication technology can potentially help clinicians and ancillary personnel to improve the overall care delivery process. These improvements will not occur unless there is a concerted effort to improve the process itself. To evaluate the impact of advanced IT on the health care delivery system requires not only standard measures, but the measurements must demonstrate that the IT caused or helped cause the observed clinical outcome. Specifically, one must be able to infer a potential relationship between the use of the IT and the observed measure.

In short, our objective is to use, as much as possible, available health outcome measures that are already being used in other clinical quality, safety, and effectiveness evaluation practices (such as Balanced Scorecard initiatives [Castaneda, 1998]). The following example measures attempt to document various aspects of the IT evaluation framework outlined above.

- Medication errors (see, for example, Kaushal, 2003)
- Percent of elderly patients (i.e., >65 yrs old) taking one or more of 10 (randomly selected) medications contraindicated in the elderly (e.g., diazapam) (Fick, 2003)
- Percent of patients with renal insufficiency taking one or more of 10 (randomly selected) medications requiring appropriate drug doses or frequency adjustments (Chertow, 2001)
- Percent of patients with active prescriptions for medications known to interact (sample of 10 randomly selected high-priority medication interactions) (Peng, 2003)
- Percent of medication orders with missing or incorrect information (randomly select 10 different medications each year for analysis) (Bizovi, 2002)
- Percent of patients on medications requiring baseline and follow-up laboratory monitoring who had them done at the appropriate time intervals (sample of 10 randomly selected medication / laboratory monitoring pairs) (Schiff, 2003)
- 30-day hospital re-admit rate (Goodney, 2003)
- Length of stay per disease related group or DRG (Shea, 1995)
- Hospital-wide, case mix adjusted length of stay (Pestotnik, 1996)
- Time in life-threatening physiologic state before treatment (Rind, 1994) (how do we control for hospitals with greater acuity?)
- Discharge on aspirin or beta blockers (Simpson, 2003)
- Time between medication order and administration (Mekhjian, 2002)
- Nosocomial infection rate (Evans, 1986)
- % of patients with duplicate laboratory orders for top 10 most commonly ordered laboratory tests in US (Bates, 1999)

IT – Health Outcome Measures

In the end, we selected the following three outcomes metrics from the above-suggested listing. The first measure attempts to provide some insight into the IT ability to catch errors or adverse events before they happen. We have described this statistics as: **percent of patients with active prescriptions for medications known to interact.**

The second metric for health outcomes is related to the system's ability to send home patients at the most appropriate time – not too early and not too long – both of which can lead to negative outcomes. We selected: **30-day hospital re-admit rate for Inflammatory Bowel Disease (IBD) patients.** In this case, we had a second issue to debate – which illness group (i.e., DRG) do we use? We wanted to select one that was quite common so that accessing data would be meaningful (not too small a sample size) and one where there would be "obvious" benefits from better information.

The final outcome measure also pertained to the IBD patient group – this time around the amount of time a patient has to stay in the hospital. The measure is: **length of stay for IBD patients.** The logic is that with better information, patients are seen faster and better decisions are made this sending the patients home sooner. (It should be remembered that we have controlled for organizations that may send patients home "too soon" with the second outcome measure (directly above). This would have the effect of penalizing those providers by raising the re-admit rate.

Next Steps

The IMPROVE-IT project brings together highly experienced clinical informaticians and health care service researchers. These researchers and consultants will now begin to use data from these institutions to calculate the specific measures to be included within our database, provide insight pertaining to the comparison and analysis of these measurements, and support the creation of benchmarks.

As stated, this research will study whether increased IT capabilities, availability, and use lead to improved clinical quality, safety, and effectiveness in the inpatient clinical setting. To reiterate, the logic underlying this hypothesis is as follows.

1) Investment in IT inherently provides newer and more powerful technology and technological solutions.
2) This improvement in IT then can generate "better" (more timely, valid, relevant, precise) information.
3) Increasing the availability and use of IT within the health care setting makes it more likely that decision-makers will access this "better" information.
4) Finally, this "better" information allows decision-makers to make "better" decisions (those that improve measurable outcomes across a variety of dimensions).

Consequently, we have established the following organization goals:

1. ***Establish a common set of IT evaluation metrics to measure system cost, infusion (i.e., capability, availability and use), and overall effectiveness in the inpatient setting.***

Accomplished herein.

2. ***Develop a secure, interactive, web-based data collection and reporting system that allows Improve-IT members to enter their performance and compare their data with a nationwide or international sample of similar institutions.***

Please refer to our website (www.improve-it-institute.org) for updated information.

3. ***Establish national and international benchmarks for all common evaluation measures.***

Recruitment of membership is ongoing. We will use member data to develop a set of national and international cost, infusion, and effectiveness benchmarks. Benchmarks will be created to identify the 10^{th}, 50^{th}, and 90^{th} percentiles of performance based on similar peer hospitals (i.e., size, type – academic or community, and geographic location, etc.).

4. ***Explore statistical relationships between measures to illustrate potential cause and effect relationships.***

During the statistical analysis, we will identify the different factors that affect the timing and the amount of benefit that one should expect from IT investment, as this will allow for better prediction and easier management of expectations. Once a model of IT valuation is created, one of the primary benefits is the awareness of the inter-relationships that exist among the many characteristics of the organization or its particular sub-industry category. For example, we should be able to demonstrate that "Increases in Hardware spending" lead to "Greater System Availability," which "Increase Clinician Usage" of the systems, then ultimately lead to "Increased Clinical Effectiveness."

5. ***Develop a complete and overall quality index that measures true impact of effective information systems in the inpatient setting.***

This will be accomplished over time as the data quality improves and the level of statistical analyses becomes more sophisticated.

Measurement Going Forward

In order for the measurement to be meaningful, in addition to identifying the specific calculations, the size and type of hospital and the type if IT implemented must be consistent within peer groups. Therefore, each member hospital will need to be categorized on the following three factors:

1. Number of Beds
2. Community care versus Academic center
3. Type of IT – physician order entry, laboratory results, diagnostic imaging, electronic health record

Within each category of hospital, benchmarks will be established as well as on-going comparisons on the IMPROVE-IT metrics. Once again, these are:

1.) IT Investment Measures

1. Amount of money spent on new IT hardware this quarter
2. Total number of people in IT staff – FTE's
3. Percentage of depreciation to assets

2a.) IT Availability Measures

1. total number of unique patients with some type of clinical data available in the clinical repository
2. system uptime
3. number of clinical applications that are available to 50% or more of the clinicians in an organization

2b.) IT Use Measures

1. percentage of clinicians with an active user-ID / password combination who actually login to the system more than 1 time each day
2. percentage of patients with a completed chart (as defined by all data needed entered and signed by all the appropriate clinicians) within 24 hours of their hospital discharge or outpatient visit
3. percentage of all orders entered directly by the patient's primary care provider

3.) IT – Health Outcome Measures

1. Percent of patients with active prescriptions for medications known to interact
2. 30-day hospital re-admit rate across IBD patients
3. Length of stay for IBD patients

It is anticipated that the mere act of identifying metrics, doing the calculations and making the comparisons will have a positive effect on effective IT utilization in healthcare. There has been much established in the field of management pertaining to the act of measurement and its effect on outcome (see Mintzberg, , among many others). The Hawthorne Effect describes the fact that people perform better when they are being watched or measured, at least in the short term. The creation of indicators will highlight the importance of IT and will motivate the member hospitals to improve their results. Even if the measures identified herein are not the optimal, they still serve a very important purpose of evaluating what is working and what is not.

Summary

While we firmly believe that the implementation and widespread adoption of IT throughout healthcare has had and will continue to have a significant positive effect, little evidence supports this belief. The proposed IMPROVE-IT project will demonstrate on a widespread scale the tremendous positive influence that IT is having on healthcare. Improving efficiency requires knowledge of current inefficiencies, and improving effectiveness requires an understanding of the measurable outcomes of health care. No process can be improved without understanding the inherent performance measures. In addition, information technology systems provide the very infrastructure by which performance measures can be generated. As such, the challenge of building effective information systems is formidable.

References

Agrawal A. Return on investment analysis for a computer-based patient record in the outpatient clinic setting. *J Assoc Acad Minor Phys* 2002 Jul; 13(3):61-65.

Ash JS, Gorman PN, Seshadri V, Hersh WR. Computerized physician order entry in U.S. hospitals: Results of a 2002 survey. *J Am Med Inform Assoc*. 2004 Mar-Apr; 11(2):95-99. Epub 2003 Nov 21.

Bates DW, Kuperman GJ, Rittenberg E, et al. A randomized trial of a computer-based intervention to reduce utilization of redundant laboratory tests. *Am J Med* 1999 Feb; 106(2):144-150.

Bizovi KE, Beckley BE, McDade MC, Adams AL, Lowe RA, Zechnich AD, Hedges JR. The effect of computer-assisted prescription writing on emergency department prescription errors. *Acad Emerg Med* 2002 Nov; 9(11):1168-1175.

Castaneda-Mendez K, Mangan K, Lavery AM. The role and application of the balanced scorecard in healthcare quality management. *J Healthc Qual* 1998 Jan-Feb; 20(1):10-13.

Chertow GM, Lee J, Kuperman GJ, Burdick E, Horsky J, Seger DL, Lee R, Mekala A, Song J, Komaroff AL, Bates DW. Guided medication dosing for inpatients with renal insufficiency. *JAMA* 2001; 286(22):2839-2844.

Conrad C, Maynard, et al. Managed care, incentives, and information: An exploratory look inside the blackbox of hospital efficiency *Health Services Research* 1996; 31(3):235-259.

Evans RS, Larsen RA, Burke JP, Gardner RM, Meier FA, Jacobson JA, Conti MT, Jacobson JT, Hulse RK. Computer surveillance of hospital-acquired infections and antibiotic use. *JAMA* 1986 Aug 22-29; 256(8):1007-1011.

Feldstein A, Smith D, Jones S, Kovach C, Soumerai S, Simon S, Sittig DF, Laferrier D, Kalter M. Design and implementation of decision support for outpatient prescribing in an electronic medical record: The safety in prescribing study. *Agency for Health Care Quality and Research research on safety* (in preparation). 2004.

Fick DM, Cooper JW, Wade WE, et al. Updating the Beers criteria for potentially inappropriate medication use in older adults: results of a US consensus panel of experts. *Arch Intern Med* 2003; 163:2716-2724

Frisse MC. The business value of health care information technology. *JAMIA* '99; 6(5):361-367.

Goodney PP, Stukel TA, Lucas FL, Finlayson EV, Birkmeyer JD. Hospital volume, length of stay, and readmission rates in high-risk surgery. *Ann Surg* 2003 Aug; 238(2):161-167.

Hatcher M. Information systems' approaches and designs and facility information: survey of acute care hospitals in the United States. *J Med Syst* 1998 Dec; 22(6):389-396.

Jones MR. Computers can land people on Mars, why can't they get them to work in a hospital? Implementation of an electronic patient record system in a UK hospital. *Methods Inf Med* 2003; 42(4):410-415.

Kaushal R, Shojania KG, Bates DW. Effects of computerized physician order entry and clinical decision support systems on medication safety: A systematic review. *Arch Intern Med* 2003 Jun 23; 163(12):1409-1416.

Kuhn, K.A., Giuse, D.A. From hospital information systems to health information systems – problems, challenges, perspectives. Yearbook of Medical Informatics 2001, Stuttgart, New York: Schattauer; 2001. p63-76.

Kuperman GJ, Gibson RF. Computer physician order entry: benefits, costs, and issues. *Ann Intern Med* 2003 Jul 1; 139(1):31-39.

Leonard KJ. Investment in information technology: The dilemma of comparing costs to benefits. *Hospital Quarterly* 1998; 1(4):53-56.

Leonard KJ. Information systems for healthcare: Why we have not had more success -The top 15 reasons. *Healthcare Management Forum* 2000; 13(3):45-51.

Leonard KJ. Critical success factors relating to healthcare's adoption of new technology: A guide to increasing the likelihood of successful implementation. *Healthcare Quarterly* 2004; 7(2):72-81.

Leonard KJ, Tan JPH, Pink G. Designing health care information systems (HCISs) for integrated delivery systems (IDSs): Where we are and where we need to be", *Topics in Health Information Management* 1998; 19(1):19-30.

Mekhjian HS, Kumar RR, Kuehn L, Bentley TD, Teater P, Thomas A, Payne B, Ahmad A. Immediate benefits realized following implementation of physician order entry at an academic medical center. *J Am Med Inform Assoc* 2002 Sep-Oct; 9(5):529-539.

Mintzberg, H. Hawthorne Effect……

Peel V. Evaluating the cost effectiveness, impact and value of hospital IT/IS implementations - lessons learned in the United Kingdom. In: Yeoh E, ed. *Proceedings of the Hospital Authority Convention 1997 - Re-inventing health care for the 21st century*. Hong Kong: Hong Kong Health Authority; 1997, pp 67-75.

Peng CC, Glassman PA, Marks IR, et al. Retrospective drug utilization review: incidence of clinically relevant potential drug-drug interactions in a large ambulatory population. *J Manag Care Pharm* 2003 Nov-Dec; 9(6):513-522.

Pestotnik SL, Classen DC, Evans RS, Burke JP. Implementing antibiotic practice guidelines through computer-assisted decision support: clinical and financial outcomes. *Ann Intern Med* 1996 May 15; 124(10):884-890.

Rind DM, Safran C, Phillips RS, Wang Q, Calkins DR, Delbanco TL, Bleich HL, Slack WV. Effect of computer-based alerts on the treatment and outcomes of hospitalized patients. *Arch Intern Med* 1994 Jul 11; 154(13):1511-1517.

Rosenstein AH. Measuring the Benefits of Clinical Decision Support: Return on Investment. *Health Care Management Review* 1999; 24(2):32-43.

Schiff GD, Klass D, Peterson J, Shah G, Bates DW. Linking laboratory and pharmacy: opportunities for reducing errors and improving care. *Arch Intern Med* 2003 Apr 28; 163(8):893-900.

Shea S, Sideli RV, DuMouchel W, Pulver G, Arons RR, Clayton PD. Computer-generated informational messages directed to physicians: effect on length of hospital stay. *J Am Med Inform Assoc* 1995 Jan-Feb; 2(1):58-64.

Simpson E, Beck C, Richard H, Eisenberg MJ, Pilote L. Drug prescriptions after acute myocardial infarction: dosage, compliance, and persistence. *Am Heart J* 2003 Mar; 145(3):438-444.

Sittig DF. Clinical Information System Return on Investment Calculations: How do we begin moving away from association toward causation? (Presented at Association of Medical Directors of Information Systems, Orlando, FL March 2004).

Sittig, D.F., Shiffman, R., Leonard, K.J., Friedman, C., Rudolph, B., Hripcsak, G., Adams, L.L., Kleinman, L.C., and Kaushal, R., (2005), "A Draft Framework for Measuring Progress towards the Development of a National Healthcare Information Infrastructure", *J Am Med Inform Assoc*, submitted.

Southon FC, Sauer C, Grant CN. Information technology in complex health services: organizational impediments to successful technology transfer and diffusion. *J Am Med Inform Assoc* 1997 Mar-Apr; 4(2):112-124.

Turunen P. A framework for evaluation of medical information systems. *Stud Health Technol Inform* 2003; 95:611-616.

Wang SJ, Middleton B, Prosser LA, Bardon CG, Spurr CD, Carchidi PJ, Kittler AF, Goldszer RC, Fairchild DG, Sussman AJ, Kuperman GJ, Bates DW. A cost-benefit analysis of electronic medical records in primary care. *Am J Med* 2003 Apr 1; 114(5):397-403.

Weingart SN, Toth M, Sands DZ, Aronson MD, Davis RB, Phillips RS. Physicians' decisions to override computerized drug alerts in primary care. *Arch Intern Med* 2003 Nov 24; 163(21):2625-1631.