HEALTH CARE TRANSFORMATION:
THE ROLE OF TECHNOLOGY
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Abstract
A growing number of health care organizations are faced with a simple question of “How can we improve quality while at the same time lower cost and remain competitive?” Industry role models have proven that appropriately applied improvement and transformation principles have resulted in an order-of-magnitude improvement.

This paper explores how some of these same techniques and approaches can be applied to the medical industry. We first review some of the causes that have forced a change in health care and some of the challenges that the industry is faced with. Next, this paper provides some insight on how health care change can be accomplished from a scientific and technology perspective through a quality management and transformation approach. Finally, some examples of how these approaches and techniques can be applied are highlighted. The examples incorporate quality improvement guidelines in an effort to identify and measure key quality characteristics that provide real meaning to the customer.

Why Must Health Care Change?
As the nation has experienced over the last several years, the health care industry is undergoing a major transformation. The once traditional fee-for-service, indemnity payer system has evolved to a capitated, fully integrated delivery system. However, long before the talk of reform, health care organizations were experiencing some of the same problems that American industries have been facing since the 1950s, a rise in cost and a demand for quality of services. This movement to high quality at a lower cost has led us to a paradigm shift in the medical industry.

According to a leading expert in the evolution of change, Joel Barker, a paradigm shift can be described as a model that helps us comprehend what we see and what we hear. Barker defines a paradigm as “a set of rules and regulations (written or unwritten) that does two things: (1) it establishes or defines boundaries; and (2) it tells you how to behave inside the boundaries in order to be successful.”

This shift to provide quality at a lower cost has been forced through such trends as capitation and managed care programs, mergers and acquisitions, accreditation, medicare/medicaid, and a better educated public. As a result, the new paradigm in health care has become a more integrated system that has the patient as the focus, with the aim of seeing significant changes in the quality of service at lower cost. Quality of care has been defined by the Institute of Medicine as “the degree to which health services for individuals and populations increase the likelihood of desired health outcomes and are consistent with current professional knowledge.” Continuous Quality Improvement (CQI) programs within health care seek to address the fundamental structural problems in our delivery system that cannot be fixed with incremental improvement.

As best stated by well known management guru Peter Drucker, “Hospitals have not changed their basic delivery system since the early 1900’s and it needs to be changed now.”

How Can Health Care Change?
This leads to the question of how can we make this transformation successful? An often quoted definition of process transformation or reengineering involves “the fundamental rethinking and radical redesign of business processes to bring about dramatic improvements in performance”. According to one business leader, “You don't reengineer unless you have to” and the health care industry has to. George W. Whetsell, a Pittsburgh consultant has slightly altered Hammer's definition to apply to health care organizations. Reengineering is “the radical redesign of the critical systems and processes used to produce, deliver and support patient care in order to achieve dramatic improvements in organizational performance within a short period of time.”

The driving forces behind transformation in American industries are the same as those that have recently affected the health care industry and can be characterized as the three Cs: customers, competition, and change. It is the customers that help create competition, and to be competitive, health care organizations must look to creative change in an effort to satisfy their customers and differentiate themselves. There are a variety of elements that create successful change, and they involve a tight
integration of cultural change, human resource change,
and technology change. Information technology is a
critical enabler in allowing organizations to experience
the order-of-magnitude improvement required to survive
today. This paper focuses on utilizing information
technology to implement quality improvement techniques
for a successful health care transformation. Information
delivery through the use of technology, allows us to do
things that we might not have deemed possible before.
Through the effective use of information technology,
decisions can be based on factual data versus
assumptions. Decisions about process transformation
require an understanding of processes in their entirety.
Steps include building the case for action and answering
several key questions. What are our needs, what do we
want to do, what is our level of readiness, and probably
most importantly, where do we want to go?

Many American organizations have tried several
initiatives to improve quality and profitability, however,
many of these initiatives have failed. What makes those
companies that thrive successful? According to Davis
Balestracci Jr., leading expert in the transformation of
health care, “the only way to significantly improve your
organization is to reduce process variation through the
application of statistical thinking.” This philosophy has
been validated by many American companies and was
born by the renown quality management consultant, W.
Edward Deming, who stated, “If I had to reduce my
message for management to just a few words, I’d say
that it all had to do with reducing variation.”

At the heart of understanding and reducing variation is
data. An essential element of quality improvement is the
analysis of data using a scientific approach. This
scientific approach involves studying the relationships
and variations in processes through the objective use of
data. A technique known as Statistical Process Control
(SPC) has been around for a long time as a means for
understanding, managing and improving process quality.
A leader in applying SPC to Health Care, James
Benneyan writes, “Statistical process control can help
management understand the performance and capability
of a process, as well as the effect of action on improving
or harming that process.” In Benneyan’s presentation
Successfully Applying SPC to Improve Health Care, he
explains, “Simply stated, quality improvement refers to
organized, rational, scientifically valid programs that
analyze what people are doing - in industry, medicine, or
any other area - and then devise ways in which the job
can be done even better.”

According to Benneyan, control charts can also
“compliment hospital epidemiology methods by
providing additional process information which
traditional methods might fail to detect.” In order to
understand and improve from process information, we
must first understand what a process is. In Davis
Balestracci’s book, Quality Improvement, Practical
Applications for Medical Group Practice, he defines
processes as a “sequence of tasks aimed at accomplishing
a particular outcome. Everyone in a process has a role of
supplier, processor, or customer. A group of related
processes is called a system.” He further explains that
process oriented thinking recognizes the following:
- all processes exhibit variation
- some variation can be controlled and some cannot
- all processes have a measurable value associated
  with them

It is the measurable value that allows us to begin to study
and analyze the variation within a process and improve
the process so a more predictable process and system can
be established. Balestracci later goes on to suggest some
of the following service process outputs that can be
measured:
- patient length of stay
- cost variances
- lost time from accidents
- percent patient “no shows”
- absenteeism
- lab test ordered
- complaints
- meetings
- telephone calls
- days per 1000
- patient satisfaction scores
- medication error rate
- time from order to shipment
- data entry errors
- percent of meeting rescheduled
- percent of meeting missed
- number of referrals to x specialty
- percent of junk mail
- percent waste
- time to retype documents
- accounts receivable by payor

Statistics, Data Analysis, and Modeling

Quality Tools and Approach

Some have suggested that the health care industry as a
whole is too complex for the application and use of
statistical process control (SPC). There have been those
who would argue that health care systems are too
different and unique to benefit from SPC. While there are
of course differences between various industries such as
Statistics, Data Analysis, and Modeling

the manufacturing and service sectors, the differences are not so great that general statistical methods do not apply. All industries have processes that are "random in nature and that the objective is to understand the process's dynamic variability and reduce it." Information technology based SPC applications have in fact been used extensively for clinical, non clinical and laboratory applications in many health care organizations. In the following section we take a closer look at many of the quality improvement techniques and technology tools and their application in health care.

One mistake that many organizations make when jumping into a quality improvement process is to collect and analyze massive amounts of data without first understanding why they are doing it and what they plan to glean from it. Objectives for improving a process must be clearly identified and operational definitions established before data collection and analysis begins. To first understand a process there are a number of very useful tools that can be applied. Flowcharts, for example, "provide an opportunity for those involved in a process to describe its current operation in a concise, visual way. Flowcharts provide everyone involved with new perspectives on process complexity and variation." They are effective tools for helping define the current actual process versus what may be the perceived process. A typical flowchart may be useful in identifying specific areas at which a process can break down. "Before any numerical data are collected, the questions "How does this process currently work?" and "How should this process work?" must be answered."

The use of flowcharts or process flow diagrams are widespread in healthcare and include organizations such as The Hitchcock Clinic Keene Division in Keene, NH, and the Scott and White Hospital in Temple Texas where "approximately 76% of patients with life-threatening infections were not achieving an adequate peak AMG level within 48 hours of therapy. Roughly half of the peak levels and toxic trough levels were not being responded to with a dosing interval or dosage adjustment." The team formed to study the problem used complex flowcharts to help define and understand and eventually redesign the process. The flowcharts helped "show that the current process of monitoring AMG levels needed to be totally restructured in order to meet mission goal." Results from the restructuring showed significant improvements in AMG monitoring, as well as a reduction in the number of steps in the process. Flowcharts can be invaluable tools for getting a handle on what the true nature of a process is.

To illustrate the graphical use of process flow diagrams, let's turn to an example from a document called Improving Service Industry Quality Using the SAS System, written by Dr. Robert Rodriguez of SAS Institute Inc. The graphical examples included within Dr. Rodriguez's document and this paper have all been created with the various quality improvement tools within the SAS® System of software and specifically SAS/QC® and SAS/AF® software. The following example is based on a case study in the book Curing Health Care by Berwick, Godfrey, and Roessner.

A Health Maintenance Organization (HMO) has three offices in a relatively small area (Oakwood, Sunnydale, and Hillsboro). Each patient has a "home" office, but in emergency situations patients are seen in any of the three offices. When patients visited offices other than their home office, emergency data was not being reliably transferred back to their home office. On subsequent visits to their home office, patients discovered that the emergency information was missing from their records. This proved to be costly in terms of both resources (time, phone calls, faxes, messengers) and quality of patient care.

The HMO decided to study this process to see why information wasn't getting to the right place. A team was set up to focus on operations at the Hillsboro office. To better understand the Hillsboro operation, the team created a process flow diagram for all the steps involved in emergency treatment of patients. The process is designed to work as follows: When a patient arrives in the emergency room, the receptionist asks the patient for his or her home facility, the receptionist then tags the patient's record, indicating the home facility. After the patient receives emergency room treatment, clinical data are given to the receptionist, sorted, and delivered (through a series of steps) to the chart room of the patient's home facility.
The diagram below shows only the first part of this (ideal) process.

Typically, a process flow diagram is used to identify specific points at which a process can go wrong. As the team began to work with the diagram, problems at various steps immediately became apparent. For example, they realized that at the step "Receptionist asks for home facility," a number of mistakes could (and did) occur. When the emergency room was very busy, the receptionist often did not request this information. And, when the receptionist did remember to ask for the information, the answers given were often incorrect, due to a number of factors (patient stress, distractions, language barriers).
Results
Analyzing the process flow diagram helped the team learn that the actual process was more complicated than they first thought. It increased their understanding of the importance of various information flows. It helped the team understand the importance of supplier-customer relationships. And, as a tool, the interactive process flow diagram environment enabled them to revise their diagram as their understanding of the process increased.

Another tool that can be useful in exploring a process is the Ishikawa diagram. Ishikawa diagrams, also referred to as cause and effect and fishbone diagrams are problem-solving tools most often used for brainstorming. They are a visual, graphical tool for organizing ideas into related categories about the relationships between inputs of undesirable problems or variations in a process. They can be useful in pinpointing problem areas for a more intense study and application of statistical analysis. Too often, diagrams get very large and unmanageable. The key to using an Ishikawa diagram is to use it in conjunction with other tools such as process flow diagrams and to focus on the specific problem at hand. Properly used Ishikawa diagrams can be an integral part of a complete quality program.

In our medical records example, once the team had created, analyzed, and then revised its process flow diagram, the group brainstormed about the factors impeding the timely transfer of information between the clinics. To make these hypotheses more meaningful, they used an Ishikawa diagram to organize the process.
The process flow diagrams and the Ishikawa diagram were included in the team's presentation to upper management. As a result, these examples show the importance of graphical technology tools to support communication and a better understanding of the process and possible root causes of problems within the process.

Once there is a clear understanding of the process and the problem areas within the process, SPC techniques can be applied to concentrate on improvements. According to Benneyan, “All health care processes exhibit some amount of variability, and all variability can be classified as either natural or unnatural. The natural variability of a process is defined as the systemic variation inherent as a regular part of the process.” These natural causes are referred to as common causes in SPC and examples of common causes might include “weight and physical condition of patients, respiratory rate, time of day, strength of phlebotomist, patient-to-patient differences, varying patient lifestyles, behaviors, and demographics.” This type of variation tends to occur in predictable and relatively common frequencies. Conversely, unnatural or special causes are those observations that represent deviations from the regular process and thus tend to be traceable to root assignable causes for management action. Such deviations are often referred to as being statistically out of control. “Examples of special causes might include changes for clinical procedures, skill degradation, equipment failure, new staff, physical change in a patient’s bodily processes, change in patient population demographics, or increased rate of disease.” Ideally, an organization that understands the difference, can take appropriate action. By using SPC methods, special causes can be identified. If you treat a common cause as special, you will try to fix a problem by adding a solution that doesn’t affect the process. The outcome will not change, yet another layer of complexity will have been added to the process.

As was mentioned earlier, special causes are typically those problems that should be addressed or fixed. In many cases, a random ad hoc approach for identifying and eliminating these problems offers little reward of improvement. Special causes not only need to be identified, but also prioritized. A noted expert in quality improvement techniques, J.M. Juran, defined what is called the “Pareto principle”. It states that 80 percent of the observed variation was generally caused by only 20 percent of the process inputs. It is often referred to as the 80/20 rule. An understanding of this principle can be very useful in understanding and improving a process. For example in health care, 20 percent of the types of medication errors generally make up 80 percent of the total errors. Or, 80 percent of a physician’s practice generally comes from 20 percent of the cases. The tool that graphically demonstrates the principle is called a Pareto diagram. Pareto diagrams help organizations visually see what problems are occurring most frequently and are often used to decide which problems should be solved first. A Pareto diagram is a bar chart that displays severity of problems in a process. The bars are ordered by frequency in decreasing order from left to right. In Davis Balestracci’s book *Quality Improvement, Practical Applications for Medical Group Practice*, Balestracci describes a medication error problem. In the problem, a hospital pharmacy wants to improve its medication error rates. Over a period of time, data were collected on error rates. It showed that of the 85 errors in the first month, 67 were made by two of the six pharmacists. Thus, 80 percent of the errors were from two of the pharmacists. In addition, when further analyzed, 80 percent of the total errors came from 20 percent of the error types. (Figure 4)
As the health care industry matures, quality of care and associated technology is becoming a top priority. Typical CQI programs have been geared towards areas such as patient focused, human resource training, improved teamwork, utilization improvements, and outcomes measurement. Missing from most quality programs within the industry is the application of SPC techniques and tools. The use of such tools can be vital in improving the quality of care. Unfortunately, these techniques and tools have yet to gain widespread use or success. There are a number of reasons for this, including a lack of understanding and knowledge of the basic theories of variability, the tools and techniques involved, and the inability or refusal of many medical schools and institutions to include such courses and information in their curriculums of education.

The use of statistical methods and ideas are vital for a better understanding of a process. One of the best SPC tools for analyzing variability of a process is a control chart. Statistical control charts are "tools for deciding whether the variation observed in a process is due to special causes." Control charts are visual plots of data over time with statistically calculated upper and lower control limits. Special causes can be identified in a control chart a number of ways. For example, a special cause may be at work when the data exhibit a trend. "A trend is defined by a sequence of at least 7 or more consecutive points which move in a single direction." A special cause can also be attributed to a process where one or more of the data points fall outside the statistical limits. The purpose of using these types of analysis is to identify the reason for the special cause and remove it, thus reducing variability in the process and establishing statistical control. Control charts plot and measure the variance of data over time in chronological order and are excellent tools for visualizing a process and identifying out-of-control events. They are used for a variety of applications in health care. For example, health care organizations have successfully used control charts to monitor hypertension levels, prescription error rates, delays in access to care, cardiac mortality rates, and to track variability in the number of days between infections.

At the 1995 National Forum on Quality Improvement in Health Conference, Dr. Larry Staker reported how he successfully uses run charts and control charts in the ambulatory care of his patients with diabetes. His goal was to empower his patients in monitoring their own glucometer FBS, while reducing variation and moving the mean value of their blood sugar down to acceptable levels. By
Individual Measurement and Moving Range Chart
Diabetes XMR Chart

Figure 5
(The control chart data were taken from Dr. Staker's handouts at the National Forum on Quality Improvement in Health Care. The chart represents 31 days of a single month in which multiple glucometer readings were taken each day. As demonstrated by the moving range control chart, there is an out-of-control point on the 30th day of the month. This represents a special cause that warrants further investigation. The Orlando version of the SAS System for Quality Improvement provides interactive tools for the creation and analysis of many types of control charts.)

using control charts Dr. Staker was able to make decisions based upon the occurrence of common versus special causes in his patients' glucometer readings. When common causes occurred, he did nothing. Conversely, if an out of control point was due to a special cause, he looked for reasons why and made the appropriate changes to his patient's care. The results and impact on his practice were a reduction in the distribution of blood sugars in his diabetic patients and a reduction of the costs per test. Of his 58 patients with diabetes, there occurred a significant shift in blood sugar means. In addition, by empowering his patients, they became more interested in learning for themselves how to decrease their blood sugar levels, resulting in fewer visits. Dr. Staker's use of statistical tools and techniques allowed him to improve the quality of care to his patients health and reduce the cost of their care.

A more advanced tool for improving a process is called Design of Experiments (DOE). The purpose of DOE is to find out which factors or inputs to a process yield the most desirable changes in outputs or responses. Outputs can vary from process performance characteristics, to reduced costs and shortened performance time. Once there is an understanding of which factors are most important in affecting the process, optimal changes to those factors can be made to improve the process. DOE is an analysis consisting of experiments which include all controllable main factors and interactions between those factors. DOE can be used throughout the industry for improving medical processes. For example, how can the process of reducing the length of stay (LOS) of patients admitted under DRG 89 (pneumonia) be improved. This case scenario was taken from an example by James Bente of Sewickley Valley Hospital. There are a number of factors or inputs than can reduce LOS for DRG 89, such as laboratory and radiology inputs, respiratory therapy and antibiotic therapy. To keep it simple, only one main input, antibiotic therapy will be reviewed. An experiment is performed with four factors related to antibiotic therapy. They are antibiotic type, antibiotic route, culture and chest physical therapy. The experiment would also involve two separate levels for each of those factors. For example, was a culture collected, yes or no, or was the antibiotic route intravenous or oral, etc. Once all combinations of factors had been experimented, the corresponding LOS information...
would then be statistically analyzed to determine the most important factors and levels of those factors for reducing length of stay. By analyzing the controllable key process variables with DOE, while also ignoring uncontrollable variables, process improvements and redesign are possible.

**Summary**

To stay competitive, health care organizations will need to find effective new ways to improve quality and lower the cost of care in this complex changing environment. Individual organizations must learn to manage this change through the integration of culture, technology and people. The effective use of SPC methods and technology tools can be utilized successfully for improving the quality of care for many areas such as optimal length of stays, patient's perceptions, improved mortality, hypertension control, drug and billing error rates, and diabetes control just to name a few. This paper is an attempt to explore transformational techniques and approaches and their application to the health care industry. We invite you to continue this investigation by referring to Dr. Robert Rodriguez's paper "Health Care Applications of Statistical Process Control: Examples Using the SAS System". His paper explores in more detail how SAS System technology for quality improvement can be utilized in health care. He cites many SAS System examples on the afore mentioned SPC charts, diagrams and analysis. Dr. Rodriguez’s paper can also be found in the SUGI 21 proceedings.

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