Organizational Change and Learning

Implementing Six Sigma in The Netherlands

Jaap van den Heuvel, M.D., M.B.A.
Ronald J.M.M. Does, Ph.D.
Ad J.J.C. Bogers, M.D., Ph.D.
Marc Berg, Ph.D.

As documented in the Institute of Medicine's two widely cited reports, health care has serious patient safety and quality problems.[1,2] Care processes are poorly designed and characterized by unnecessary duplication of services and long waiting times and delays. As a result, health care is not meeting patients' needs—and needs to be redesigned.

In this article we describe how Six Sigma can be used to improve care processes, eliminate waste, reduce costs, and enhance patient satisfaction.

What is Six Sigma and How Does It Work?

Six Sigma is a process-focused strategy and methodology for business improvement that was developed by Motorola in 1987 and popularized by General Electric in the late 1990s.[3] Subsequently, many companies, such as American Express, Boeing, Citibank, Ford, and 3M have followed General Electric.[4] More recently, application of Six Sigma has also been suggested in health care.[5,6] Organizations that implement Six Sigma invest in quality improvement, cost reduction, and efficiency improvement. The *sigma level* indicates the defect rate in a given (production or service) process. Defects have serious implications—they increase costs, increase lead time, and reduce quality. Six Sigma tackles these problems by reducing the number of defects.[7] Several variants of the program are currently in use.[4,8]

Six Sigma entails an elaborate organizational structure of project leaders and project owners. Six Sigma project leaders, who are called Black Belts and/or Green Belts, constitute a well-trained task force. An experienced Black Belt can be appointed a Master Black Belt,

Article-at-a-Glance

Background: Six Sigma, a process-focused strategy and methodology for business improvement, can be used to improve care processes, eliminate waste, reduce costs, and enhance patient satisfaction.

Experience with Six Sigma in The Netherlands: Six Sigma was introduced in 2001 at the 384-bed Red Cross Hospital (Beverwijk). During the Green Belt training, every participant was required to participate in at least one Six Sigma project. The hospital's total savings in 2004 amounted to $1.4 million, for an average savings of $67,000 for each of the completed 21 projects.

Three Examples of Successful Projects: In one project, the team designed a new admission process for the operating rooms, resulting in an average starting time nine minutes earlier. This relatively minor improvement made it possible to operate on an additional 400 patients a year and to achieve a net savings of > $273,000. A second project reduced the number of patients receiving intravenous (IV) antibiotics by switching to oral administration, yielding an annual savings, based on medication costs alone, of > $75,000. A third project reduced the length of stay in the delivery room from 11.9 to 3.4 hours, yielding an annual savings of $68,000.

The "Ultimate Cure?": Six Sigma, which entails involvement of health care workers; use of improvement tools (from industry); creation of trained project teams to tackle complex, often crossdepartmental processes; data analyses; and investment in quality improvement may prove the "ultimate cure" to the current cost, quality, and safety issues that challenge health care.

who coaches and trains Black Belts and Green Belts and has expertise in Six Sigma statistical tools and project leadership. Senior managers, as Champions, serve as project owners/coaches. Through this structure, Six Sigma is able to combine the available knowledge and experience from various functions in an organization to achieve the best possible process improvements.[9]

Deployment of the Six Sigma program is done by carrying out improvement projects with a 12-step "breakthrough cookbook," a problem-solving method designed to lead a Six Sigma Black or Green Belt to significant improvements within a defined process.[8] According to the cookbook, problems are addressed in four phases—Measure, Analyze, Improve, and Control. In more recent accounts of the methodology, a Define phase precedes the other four phases.[4] It consists of three steps:

1. Suggestions for potential projects are collected. Suggestions can be made bottom up, for example, by Black or Green Belts, who are familiar with operational problems and flaws, or top down, when senior managers (Champions) raise strategic issues. Projects may be related to problems in health care processes, hospital strategy, customer (patient) demands, or costs of poor quality. For each suggested project a Black or Green Belt is selected to conduct the project. He should have context knowledge about the problem and relevant hands-on experience.

2. The Black Belt or Green Belt prepares the project proposal. This proposal consists of a business case, a plan, and an explanation of how the project would support the organization's strategic goals.

3. The Master Black Belt and the Champions prioritize the proposed projects and select the most promising ones. The prioritization is based on the project's quality improvement potential, financial benefits, positive side effects, and strategic impact, as well as the feasibility of completing the project within four to six months (although projects in the first wave often take longer).

A project is started only if a certain amount of net savings can be achieved. Because a project entails studying a problem to find its causes and to develop a solution, problems that have a known cause or a known solution do not require a Six Sigma approach but just need someone to implement the solution.

In the Measure phase, the problem is translated into a measurable form by means of a Critical To Quality (CTQ) characteristic. The analysis of the current situation and the identification of influence factors of the CTQ take place in the Analyze phase. In the Improve phase, Black Belt or Green Belt designs and implements adjustments to the process to improve the performance of the CTQ. Finally, in the Control phase, the process management and quality control system are adjusted to ensure that improvements are sustainable. Each of the four phases consists of several steps, as shown in Table 1 (page 395), which guide a project leader through the execution of an improvement project.[8]

Tools used in Six Sigma, such as Quality Function Deployment (QFD) and Pareto analysis, link customer demands to product features and, supported by various statistical techniques, establish the relative importance of various problems. The Champions review the progress of a project and ensure that the Black Belts and Green Belts focus on the interests of the organization.

Experience with Six Sigma in the United States

One of the first health care organizations to fully implement Six Sigma was Commonwealth Health Corporation in 1998,[10] with the help of consultants from General Electric. By early 2002, Commonwealth had invested about $900,000 in Six Sigma and realized improvements worth more than $2.5 million.[11] A number of health care organizations have followed the example of Commonwealth Health Corporation and achieved even better results.[12] For example, Mount Carmel Health System, a three-hospital system in Columbus, Ohio, with 7,300 employees, reported a financial return of $3.1 million.[11] Charleston Area Medical Center, a 919-bed three-campus medical center in West Virginia, achieved a savings of $841,000 in supply chain management.[13] Thibodaux Regional Medical Center, a nonprofit 149-bed hospital in Louisiana, started implementing Six Sigma in 2001 and in May 2002 reported an annual savings of more than $475,000.[14]

Finally, Fairview Health Services (FHS) in Minneapolis, one of the four major health care providers in the Twin Cities area, began with a partial deployment of Six Sigma in February 2002. Yet even before completing analyses of

Table 1. Six Sigma Five-Step Improvement Method*

Define	Project identification, project proposal, project selection
Measure	1. Select internal Critical To Quality (CTQ) 2. Operationalize the CTQ 3. Validate measuring procedure
Analyze	4. Determine process performance 5. Determine project goals 6. Identify potential influence factors
Improve	7. Select most important influence factors 8. Establish relationship between CTQ and influence factors 9. Design improvement actions
Control	10. Adjust quality control system 11. Determine new process performance 12. Close the project

Adapted from Does R.M.J.J., Koning H.: *Lean Six Sigma for Service and Health Care*. Alphen aan de Rijn, The Netherlands: Beaumont Quality Publications, 2006.

the pilot projects, FHS decided to proceed with full deployment. Leaders developed strategic and communication plans, allocated resources, and provided for further training. In 2005, three years after the initial implementation period, FHS had developed a systemwide method for setting priorities for performance improvement projects, supported by a Web-based system for managing, tracking, monitoring, and communicating results.[15]

Experience with Six Sigma in The Netherlands

Implementation

In its first documented use in health care in The Netherlands, Six Sigma was introduced in 2001 at the Red Cross Hospital in Beverwijk, a town of 38,000, to enhance continuous improvement. A 384-bed, medium-sized general hospital, Red Cross Hospital had an annual budget of $90 million in 2004 and admitted 12,669 patients, performed 11,064 outpatient treatments, received 78,832 first visits to its outpatient units, and maintains a national 25-bed burn care center. The hospital had already been certified by the International Organization for Standardization (ISO: 9000) in 2000.[16] ISO and Six Sigma methods had been shown to complement each other in other organizations.[17,18]

An external consulting company conducted a one-day training course in Six Sigma at the Red Cross Hospital for the management team (two directors and the managers of the hospital's four divisions) at the end of 2001. The quality manager went through intensive Black Belt training in Spring 2002, and 16 employees enrolled in in-house Green Belt training in September 2002. During the Green Belt training, every participant was required to participate in one Six Sigma project. One of the hospital directors and the managers of the divisions also participated in this first wave of Green Belt training. During the course, which consisted of two separate, three-day periods, each participant had to produce specific results. Green Belt projects were not allowed to progress to the next phase until the preceding phase was completed. The participants had to present their results twice before the entire group.

Because of the hospital's small size, Green Belts rather than Black Belts conducted the projects. Every Green Belt conducted at least one project, and for most of the projects, two Green Belts worked together. The Green Belts typically spent one or two days a week on their projects. An estimated savings of $25,000 was set as the financial threshold for initiating a project. After the first wave of Green Belts were trained, management started a second group of 15 Green Belts in February 2003, a third group of 13 Green Belts in September 2003, a fourth group of 14 Green Belts in February 2004, and a fifth group of 17 Green Belts in September 2004.

Initially, the hospital's Black Belt performed the role of Master Black Belt on a part-time basis. Because we wanted to deploy Six Sigma relatively fast, we decided to employ an external, full-time Master Black Belt—who came from industry rather than health care, reflecting Six Sigma's universality. This did not prove to be a problem.

The hospital's total savings in 2004 amounted to $1.4 million, for an average savings of $67,000 for each of the completed 21 projects. The expected total net annual savings of all projects were estimated at $3.6 million.[19] We have been able to initiate Six Sigma projects in almost every unit and involve every discipline in the hospital.[20]

At the beginning of 2004, the hospital anticipated serious financial problems. Management deployed Six Sigma to initiate an additional number of smaller, quick-win projects instead of discharging personnel. With this additional savings of $1.2 million, the net savings for 2004 amounted to $2.4 million.

Red Cross Hospital's experience suggests that, given an enthusiastic first group of Green Belts and achievements in quality and costs, Six Sigma can produce substantial results in less than six months. The components of Six Sigma are very similar to those of total quality management (TQM)—leadership, culture, philosophy, technical and analytical skills, structure and organization, people skills, and above all, a customer focus.[21] Although we tried to implement TQM in our hospital, it never produced the turnaround and results that we were able to achieve with Six Sigma. In our opinion there are two reasons that can account for this observation. First, Six Sigma provides a very detailed description of the way it should be implemented and the tools that have to be used. After starting with Six Sigma, one could say that everyone's roles, tasks, and activities are defined for the coming year. TQM is much less specific and more philosophic. Second, TQM first focuses on management to promote the philosophy and motivate employees. Six Sigma focuses on employees, providing them the instruction and tools to solve their everyday problems—in the context of an organizational framework and overall philosophy and culture. In this way, Six Sigma creates a large number of motivated and successful "ambassadors" of quality.

Three Examples of Successful Projects

Three examples of successful projects are provided.

Optimizing the Use of Operating Rooms (ORs), September 2003–July 2004. This project was aimed at optimizing the use of ORs just by starting on time in the morning and using all available time. The hospital's official starting time was 8:00 A.M. Yet data collected in the Measure phase showed that the average starting time (CTQ) was 8:33 A.M. During the Analysis phase, the Green Belt team identified a number of causes for late starts:

- Patients were brought in late or had not yet been given the proper medication.
- Insufficient nursing staff were available.
- Surgeons wanted to make their rounds first.
- Anesthesiologists were late.

The Green Belt team discovered that there was no unique straightforward reason for starting late but that the underlying problem was a poorly defined planning process. It designed a new admission process on the basis of a few simple rules:

- Patients must be present at the OR no later than 7:35 A.M.
- Measurements have to be taken to ensure that patients first receive pre-operative medication.
- The referring department and the anesthesiologist have to be informed one day in advance of a procedure.

To control this new planning process "visual management," in which graphs showing the OR targets and actual OR start times for the previous week are displayed on posters, was introduced. The resulting graph is reviewed weekly. The Six Sigma approach was very helpful to provide real insight into the problem and to avoid the classical blaming of the other party.

One year after the project's start (September 2004), the OR start times averaged 8.24 A.M. Even this relatively minor improvement in starting time—and consequently in use of the available time in eight ORs—made it possible to operate on an additional 400 patients to achieve a net savings of more than $273,000 without additional resources. This project, which is still ongoing, clearly shows that reducing waiting times and especially reducing surgery cancellations at the end of the day can lower costs and increase quality.

Reducing the Number of Patients Receiving Intravenous (IV) Antibiotics, September 2002–May 2003. Compared with oral administration of medications, IV administration is more prone to produce errors, takes more time for nurses and pharmacy for preparation and administration, is more expensive, and is less convenient and comfortable for patients. This project was intended to reduce the number of patients receiving IV antibiotics by switching to oral administration as soon as possible. The CTQ was defined as the percentage of unnecessary IV admissions per week. Criteria were developed to determine whether IV administration was necessary. Measurements were performed at two departments in a three-month period. One department showed 19% unnecessary IV administrations, and the other one showed none.

During the Analysis phase, the Green Belt team identified a number of causes for inappropriate IV administration:

- Lack of structured evaluation (for example, transfer to oral medication was not part of the treatment protocol)
- Criteria to switch from IV to oral administration were unknown
- Lack of information about (oral) alternatives
- Workload in the nursing department

A number of improvements were designed and implemented, such as the development of new protocols containing switch criteria and an automatic alert to evaluate the medication, which was built into the computer program that managed medication prescriptions. Because chart review is very time consuming, the project's results were monitored by measuring the use of IV medication (for example, the antibiotic cyprofloxacin, which is particularly expensive).

Whereas 291 patients received IV medications in September 2002, only 157 patients did so in September 2004, yielding an annual savings, based on medication costs alone, of more than $75,000.

Reducing Delivery Room Length of Stay After Delivery, March 2004–December 2004. The hospital was facing insufficient capacity in delivery rooms; it was impossible to increase the number of rooms. The average length of stay of mother and child after delivery was approximately 11.9 hours, with only 20% of the mothers staying less than four hours after delivery. To reduce this length of stay, we designed a new protocol with discharge criteria, a check list, and additional procedures. We provided information leaflets about the discharge procedure to be distributed by midwives in the outpatient department and an information booklet, "The First Hours at Home with your Baby," to be taken by the mother at discharge. Home care facilities were improved, and a new discharge letter to be given to the mother's general practitioner (primary care provider) was designed.

After implementation of these measures, we were able to reduce the length of stay 11.9 to 3.4 hours, resulting in an annual savings of $68,000.

Why Six Sigma Makes Even More Sense for Health Care

To fully understand the potential of Six Sigma in quality management in health care, it is necessary to take a closer look at the way quality is defined.[22] Garvin has identified five major approaches of defining quality in industry[23]; and most existing definitions of quality fall into one of these approaches:

- Transcendent approach of philosophy: Quality is innate excellence and cannot be defined
- Product-based approach of economics: Quality reflects the presence or absence of measurable product attributes, and more quality (attributes) means more costs
- User (client)-based approach of economics, marketing, and operations management: Individual consumers have different wants or needs, and those goods that best satisfy their preferences have the highest quality
- Manufacturing-based approach: Quality as conformance to requirements, so that improvements in quality (reductions in defects) lead to lower costs
- Value-based approach of operations management: A quality product provides performance at an acceptable price of conformance at an acceptable cost.

Garvin concluded that a company should not rely on a single definition of quality but rather should cultivate all five quality approaches.

Consideration of the five approaches to quality in health care can illustrate the power of Six Sigma. The transcendental approach, unfortunately, is often used by health care professionals, but an inability to define or measure quality will severely impede quality improvement initiatives. Six Sigma stimulates health care workers to define, measure, and improve aspects of quality. Our experience with Six Sigma at the Red Cross Hospital has shown that its focus on data and statistical verification is an excellent counterbalance to the subjective and intuitive (transcendental) approach.

In terms of the product-, user-, and manufacturing-based approaches in health care, we observe a very interesting phenomenon. A patient is not only our client but also our product (we replace parts), and is the most important element of our manufacturing (i.e. health care) process—thereby representing three approaches to quality at the same time. Therefore, we are obliged to manage *all three quality approaches* during the entire health care process. This largely explains the complexity of our work and the vast challenges we face in quality management in health care.

We once asked our Master Black Belt, who had had five years' experience at a large truck manufacturing company, the following question: "What would happen if the future truck driver is on the truck you are assembling during the entire production process, asking questions, making new requests, and being annoyed by waiting times and paint spilled on his trousers?" He admitted that the entire plant would become a mess! This, however, represents daily practice in every hospital, and explains much about the origins of a "quality chasm"[2] in health care.

Because the patient is part of the manufacturing process, improving the quality of the health care process will by definition lead to lower costs and higher quality of care. This quality of care will be seen in shorter waiting times and length of stay; fewer examinations; and fewer defects, such as errors, unnecessary interventions, and complications. Furthermore, Six Sigma links client demands to product attributes. This prevents health care workers from delivering care that patients do not expect to be delivered and also reduces costs. So, especially in health care, Six Sigma seems to work both ways; costs are eliminated and quality is improved.[24]

The fact that the patient is part of the manufacturing process also provides an explanation for the kinds of patient safety problems cited by the Institute of Medicine reports. In industry, a high-quality product can be manufactured regardless or even because of the fact that a large number of (imperfect) products are rejected. The customer only experiences the high-quality product and is neither aware of, nor affected by, the undesired output of an imperfect manufacturing process. Yet unlike industry, where a defective product can be rejected without any problem, in health care an imperfect process that produces defects and rework directly affects the patient's safety. Therefore, Six Sigma can be used to improve patient safety by reducing the number of defects (for example, medical errors[25]) produced by health care processes.

Finally, in terms of the fifth, value-based approach, it is evident that contrary to the experience in industry, pricing mechanisms do not function well in health care. In general, patients just want maximum quality and insurance companies, government, and other payers want to pay the lowest price. Reimbursement systems do not generally explicitly reward additional quality of care.[26,27] As a result, the hospital is torn between the demands of quality and cost. The only sensible policy for any hospital to pass both Scylla and Charybdis is to maximize efficiency while at least preserving quality of care. Again, this means investing in health care process improvement, which, we contend, will invariably lead to lower costs and higher quality of care.

Improvement of patient safety can be viewed as a valuable "side effect" of Six Sigma. In the Netherlands, policy makers have defined patient safety as an issue on its own requiring separate management systems. Yet by taking the patient as the starting point, Six Sigma provides a balanced approach to quality and safety. In each of the three projects cited, for example, we were able to achieve at least two of the three goals—cost reduction, quality improvement, and patient safety.

The "Ultimate Cure?"

In depicting the scope and purpose of continuous process improvement in health care in 1989, Donald Berwick pointed to the need for involvement of health care workers; use of improvement tools (from industry); creation of trained project teams to tackle complex, often cross-departmental processes; data analyses; and investment in quality improvement.[28] In fact, these all constitute the elements of a Six Sigma organization, as represented in the Red Cross Hospital and elsewhere. Six Sigma, we dare to claim, may prove the "ultimate cure" to the current cost, quality, and safety issues that challenge health care. J

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Jaap van den Heuvel, M.D., M.B.A., formerly Chief Executive Officer of the Red Cross Hospital, Beverwijk, The Netherlands, is Chief Executive Officer of Canisius Wilhelmina Hospital, Nijmegen, The Netherlands. **Ronald J.M.M. Does, Ph.D.** is Professor, Institute for Business and Industrial Statistics, University of Amsterdam, Amsterdam, The Netherlands. **Ad J.J.C. Bogers, M.D., Ph.D.,** is Professor, Department of Cardiothoracic Surgery, Erasmus Medical Center, Rotterdam, The Netherlands. **Marc Berg, Ph.D.,** is Professor, Institute of Health Policy and Management, Erasmus University, Rotterdam. Please address correspondence to Jaap van den Heuvel, j.v.d.heuvel@cwz.nl.

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