Process Improvement in Healthcare

Gerard C. Niemeijer



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"*If you can't describe what you are doing as a process, you don't know what you are doing*."

- W. Edwards Deming (1900-1993)



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Dit proefschrift is mede mogelijk gemaakt door een financiële bijdrage van het Instituut voor Bedrijfs- en Industriële Statistiek van de Universiteit van Amsterdam (IBIS UvA).

Omslagontwerp: Henriët Niemeijer

ISBN: 978-94-6108-313-5

Druk: Gildeprint Drukkerijen

Process Improvement in Healthcare

ACADEMISCH PROEFSCHRIFT

ter verkrijging van de graad van doctor
aan de Universiteit van Amsterdam
op gezag van de Rector Magnificus
prof. dr. D.C. van den Boom
ten overstaan van een door het college voor promoties ingestelde
commissie, in het openbaar te verdedigen in de Agnietenkapel
op dinsdag 3 juli 2012, te 12.00 uur

door

Gerard Christiaan Niemeijer

geboren te Groningen

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PREFACE

Four years ago, in 2008, “The Institute for Business and Industrial Statistics of the University of Amsterdam” introduced me to the world of Lean Six Sigma and continuous process improvement in healthcare at the University Medical Center Groningen. It was the start of an inspiring journey and the basis of this thesis.

First of all, I would like to thank my co-promoter Albert Trip. I am very grateful to Albert for his excellent coaching from the beginning to the completion of this thesis. This thesis would not have been written at all without his help. Also very special thanks to my promoter professor Ronald Does. His energy, enthusiasm, support and knowledge were essential to complete this journey. Ronald and Albert, I will always keep good memories to “the pressure cooking method” to finalize this thesis.

I also would thank my 2nd promoter professor Kees Ahaus for all his help, suggestions and precise corrections. Of course also a special thank to my 2nd co-promoter Klaus Wendt for supporting and facilitating me to accomplish the process improvement projects and to be a true Champion for the projects at the department of Traumatology. Professor Henk Jan ten Duis, thanks for your confidence and for initiating this study. Special words of thanks go to the late professor Søren Bisgaard and my co-authors professor Jeroen de Mast and Jaap van den Heuvel.

I am grateful to all my colleagues (staff members) at the department of Surgery/ Traumatology. Special thanks to Geessiena Wildeman, Lolke Lolkema and Wim Helmholt for their collaboration and support to successfully implement process improvements. I would express my gratitude to Lina van der Ploeg for all the lessons learned about project management and strategy and for supporting my career and education at the department of

Surgery. Furthermore, I want to thank all the colleagues at the department of Surgery and at the UMCG for the collaboration during the improvement projects and helping me to collect the evaluation data.

None of all this this could have been realized without the support of my family. I am greatly indebted to my parents Chris and Janny for showing their everlasting interest in my work and for teaching me how to work results-driven. Undoubtedly, my wife Henriët deserves a special word of appreciation for her moral support, patience and love. Last but not least, I want to thank my two sons Robin and Marco, for their interest, smiles and the moments of relaxation at the tatami. I know for sure that some day, both of you will earn your own black belt.

Gerard Niemeijer

July 2012

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Chapter 1

IMPROVING QUALITY IN HEALTHCARE

1.1 Introduction

Cost and quality of healthcare are two critical issues facing the healthcare industry throughout the world. Finding ways to improve quality and reduce costs is therefore one of the most important issues facing the medical profession as well as the public in general. Leaving it to healthcare administrators to worry about costs and the clinical staff to worry about quality is not a recommended approach. The two sides need to collaborate closely to obtain better quality while controlling the spiraling costs of healthcare. In this chapter we discuss the three definitions of quality promoted by quality management pioneer Dr. Joseph M. Juran (Juran, 1989). Conceptually, these definitions may help healthcare professionals ─ clinicians and administrators ─ clarify the relationship between cost and quality and explain the seemingly paradoxical idea that we can indeed enhance quality while reducing cost of healthcare.

Furthermore, we discuss in this chapter quality performance indicators. Current indicators appear to be inadequate to inform the public to make the right choices. We propose a framework and an organizational setting in which valid and reliable healthcare information can be produced to inform the general public about healthcare quality.

Finally, the chapter ends with an outline of this thesis.

1.2 Improving quality in healthcare while reducing costs

The term quality has several interpretations. Confusing them may cause problems, some of which may confuse policy discussions, create conflicts between patients, healthcare professionals and hospital management, and impede progress in solving problems with the healthcare system. If the prevailing paradigm is that reducing cost inevitably will compromise the quality of care, the very mindset becomes an obstacle to dealing with some of the most vexing problems of modern healthcare.

The majority of activities in professional organizations are done as routines, and "routinization" (that is, turning something into a process) of activities constitutes the most important form of storage of an organization's specific operational knowledge. Process management has an analogy with financial management. The latter is carried out through

three managerial processes: financial planning (budgeting), financial control (budget) and financial improvement (cost reduction). It was Juran (1989) who explores this analogy for managing quality. It may seem logical to implement process planning before engaging in process control and process improvement. However, Juran suggested that it is more pragmatic to start with improvement (Bisgaard, 2007).

Perhaps the first association that people make with the topic of healthcare improvement is innovation in medical science, including innovations in treatment protocols, medical equipment, and pharmaceuticals. The first subsections of this chapter, however, focus on the improvement of healthcare by improving its delivery. Healthcare delivery concerns the operating routines in hospitals, including primary patient processes, medical support processes, and nonmedical support processes. Characteristics of these processes, such as their capacity, efficiency, and reliability, determine important performance dimensions of healthcare, such as throughput, patient safety, and waiting times. Ultimately, they have a substantial impact on patient satisfaction, cost, and the quality and timeliness of medical care.

1.2.1 Quality as fitness for use

Juran's primary definition of quality is "fitness for use" (Juran, 1989). This somewhat peculiar definition implies that more is not necessarily better. Instead, the paramount focus should be patient needs and expectations. Quality as "fitness for use" provides a conceptual guide for caregivers to focus attention on what is "fit" for the patient in his or her current circumstances and helps clinicians clarify what is needed to prevent "overuse", "underuse" or "misuse" (Becher and Chassin, 2001). For example, patients do not want to undergo large or risky surgical procedures or diagnostic tests unless there is a reasonable probability of benefit to their healthcare condition. It is the healthcare workers' professional responsibility to judiciously apply the fruits of medical science to that end. Most patients are realistic and do not expect miracles. However, it has been observed that healthcare professionals ─ possibly out of fear ─ sometimes prescribe tests, procedures and medications regardless of cost and without sufficient consideration of relevance and effectiveness (Chassin and Galvin, 1998; Schuster, McGlynn and Brook, 1998; Institute of Medicine, 2001, Chapter 8). On the other hand, situations also occur where healthcare administrators or funding agencies try to ration tests, procedures and medications. By establishing actual needs, clinicians should stay true to the principle that the only tests and medical procedures that should be administered, are those that contribute to satisfy these needs.

Juran's definition of quality as "fitness for use" may offer clinicians a conceptual framework for thinking through how to provide better quality while reducing costs. As an example: more costly procedures do not necessarily imply better quality of life; one cancer patient may desire to live as long as possible and endure the hardships of chemotherapy, radiation therapy, and operative procedures; another cancer patient may wish to receive palliative care and spend the available time at home with the family. Obviously, the cost implications differ significantly. Every possible therapy within medical and ethical standards should be made available, but the final choice should be based on the principle of "fitness for use" for the particular patient.

Although "fitness for use" is the predominant definition, Juran realized a need for further subsidiary definitions, chiefly for economic reasons, and we will cover these in the next two subsections.

1.2.2 Quality as features

Juran further quantifies "fitness for use" in two different categories: quality as "features" and quality as "freedom from deficiencies" (Juran, 1989). Both have important implications for conceptualizing the quality of healthcare and helping to clarify the relationship between quality and cost. Quality as "features of a product or service" implies that more features lead to better quality. However, more features typically cost more. There are, or should at least be, two reasons to add features in healthcare. The first is the patients' justifiable needs, the likelihood of improved health, and ─ ultimately ─ improved quality of life. The second reason is the state of the art of medical knowledge and technology. For example, in the past, coronary artery obstruction was treated with balloon dilatation. Today this procedure usually requires specially coated stents to be implanted as well, which adds significantly to the cost.

In the upper portion of Figure 1.1, we have sketched out the economic relationship between quality interpreted as features, cost, and revenues. In a fee-for-service system (Institute of Medicine, 2001, Chapter 8) and certain other pay systems, added features may have the following financial benefits to the provider: Better healthcare attracts more patients and produces more revenues, provided that the additional features are paid for, and typically, that margins are higher for more expensive features.

The definition of quality as "features of a product or service" forces us to make tradeoffs between quality and costs. Unfortunately, improved quality as "more features" often

is the only definition people implicitly have in mind when they talk about healthcare quality. Such a mindset causes many healthcare professionals, administrators, politicians and the general public to assume that reducing costs inevitably will force us to compromise quality. However, as we will discuss in the next subsection, that is not necessarily so.

1.2.3 Quality as freedom from deficiencies

Juran's second subsidiary definition of quality as "freedom from deficiencies" has the opposite cost implication (Juran, 1989). Fewer deficiencies cost less! Costs are reduced if we succeed in lowering the number of deficiencies: e.g. fewer medication errors, rejected products, lost paperwork, missing X-rays, rework, delays, fewer hospital acquired infections, and lost materials due to failures and mistakes. The focus of this definition is typically not on the "product or service" as in the "features" definition, but is related primarily to processes, either clinical or administrative.

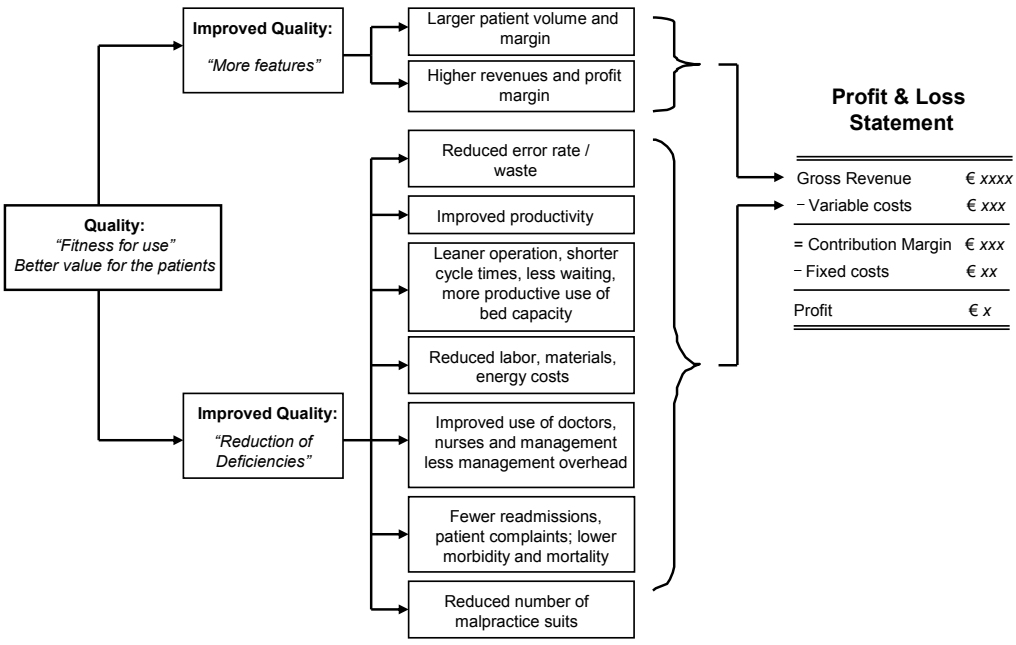


Figure 1.1: Graphical summary of the main economic relations of quality defined as "features" and "freedom from deficiencies".

As indicated in the lower portion of Figure 1.1, the reduction of deficiencies in healthcare and administrative processes results in many cost reductions at all levels in the organization.

As in manufacturing, efforts intended to improve the "production" process of healthcare services (that is: healthcare delivery) invariably lead to lower costs for the provider. But there is also a crucial difference between manufacturing and healthcare that has further cost implications. For instance, if the number of rejected cars at the end of a production line is reduced from 20 to 2 percent, costs related to rework will be significantly reduced. However, with effective outgoing inspection, the customer will experience only cars that meet given quality standards. In healthcare, if 20 percent of the operations in a hospital are not successful, it directly affects the patients. Failures, defects and rework in healthcare processes, are synonymous with complications, inconvenience, waiting and delays, morbidity and mortality rates. Thus, in healthcare deficiencies not only increase costs but also reduce the quality of care, and always impact the patients adversely. For example: postoperative wound infections result in costly lengthened hospital stays and the risk of death. In healthcare, the patient and the product are one and the same; the customer (i.e. the patient) is intimately involved in the delivery process (Van den Heuvel et al., 2006). Consequently, in healthcare there is a direct loop from improved process quality to improved healthcare product quality.

1.2.4 Examples of improving quality while reducing costs

So how do we improve quality of healthcare while reducing cost? In this subsection we provide already a few concrete examples of the use of Lean Six Sigma, a data-driven scientific approach to quality improvement that has been popular in industry for some time. In the next chapters we will discuss Lean Six Sigma and its impact in healthcare in more detail. Lean Six Sigma's main focus is on improving quality while reducing cost. Lean Six Sigma has lately also been used with success in healthcare (De Koning et al., 2006). Its main strength is the application of a scientific and data-driven approach to problem solving and its use of a broad spectrum of quality improvement tools and techniques, many of which are statistical. Improvements are achieved by a team based, project-by-project approach involving hospital employees trained in the Lean Six Sigma methodology. From a database of more than 500 successfully completed projects in thirteen medium or large hospitals in the Netherlands a few examples are given. These projects focused on improving processes, clinical as well as administrative, either by reducing the number of deficiencies or by reducing non-value adding

activities. Each project has produced savings of at least €20,000 and some projects saved more than a million euros.

Some examples are:

1. Reducing the length of stay for COPD patients from 10 days to 7.5 days (Bisgaard and Does, 2009)
2. Reducing the number of errors in invoices from 10% to less than 1% (Van den Heuvel et al., 2005)
3. Optimizing the utilization of operating rooms by reducing the delay in start-time by 50% (Does et al., 2009)
4. Increase the availability of infusion pumps in a hospital to 100% while reducing the total number of infusion pumps by 20% (Kemper et al., 2009)
5. Improved staffing of nurses in the maternity ward by aligning the right people to the right job and reducing the number of temporary workers (Wijma et al., 2009)

Money saved in these projects was used either to reduce budget shortfalls, or to reinvest in quality features, innovations or new equipment.

1.3 The challenges of measuring healthcare quality

Quality of healthcare has many facets and can be measured in many ways. Unfortunately, this is done in a non-standardized way by multiple organizations in the Netherlands. A weekly magazine called Elsevier started publishing hospital rankings in 1997, based on expert opinions from general practitioners, physicians, nurses, managers and board members (Hen et al., 1997). The Dutch Healthcare Inspectorate developed an ever-expanding quality performance indicator (PI) list that hospital staff are obliged to measure and report to the inspectorate. The reported results are rarely verified, however, so reliability is dubious. A Dutch newspaper yearly publishes hospital rankings based on selected Healthcare Inspectorate quality PIs, multiplied by the newspaper's own weighting factor (Geenen and Wessels, 2004). Patient organizations developed their own specific quality PIs related to explicit diseases, such as diabetes, breast cancer, and colon carcinoma (NPCF 2010; Ronde and Smit-Winterink, 2003). Healthcare insurance companies followed with their attempts to measure quality based on quality PIs, i.e. specific indicators developed by patient organizations and the Consumer Quality Index (Stubbe et al., 2007). In 2011 a yearly guide (Dr. Yep) was published for the first time, ranking hospitals based on information provided by staff, the Healthcare Inspectorate PIs, and mystery guest experiences (Dokter et al., 2011).

Another recent attempt from 2010 is the combination of Elsevier's revised list based on public data such as the Healthcare Inspectorate PIs with treatment admission times.

In this information labyrinth a hospital can get very different scores, depending on the survey. In Figure 1.2 we illustrate this phenomenon by a scatterplot of the rankings from Elsevier and the Dutch newspaper (AD). Since criteria of one survey can also change from year to year, this alone may cause differences in the ranking, even without real changes.

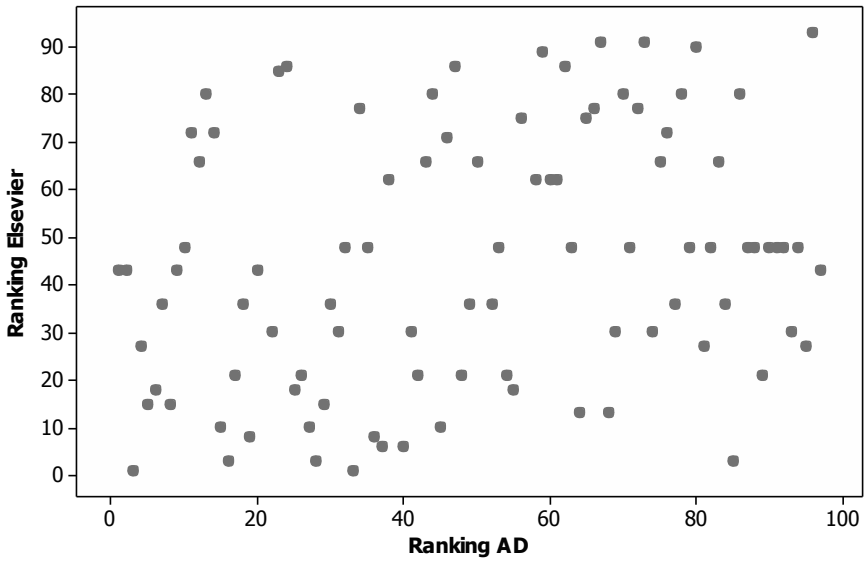


Figure 1.2: Scatterplot of rankings of two different surveys.

Surveys invariably claim to measure healthcare quality, however, leaving patients confused by inconsistencies and ever changing rankings. Despite this claim, Lingsma (2010, pp.240-242) concludes that the Dutch general public has access to different process and outcome measures, none of which represents quality of care. In this section, we introduce a framework and an organizational setting for measuring healthcare quality that provides standardized, valid and reliable information to the public.

1.3.1 Lessons learned from financial accounting

Pronovost et al. (2008) state that reporting on quality measures in healthcare is like the Wild West, dramatically different from financial reporting. They suggest that healthcare managers could learn from the generally accepted accounting principles in the United States of America (US GAAP) as a model to develop a public healthcare-quality reporting system (Pronovost et al., 2007). Porter and Teisberg (2006, 2007) argue that unbiased and reliable public reporting is the only way to expect a value-based competition on results and in turn affordable high-quality healthcare. To better understand the Pronovost analogy, the GAAP's purpose is to assure the public that stocks represent the value as stated, and that the information provided by the company can be trusted. GAAP's role is an external one relative to the stakeholders and the public, and its information pertains to the company's economic performance reported in the income statement and the balance sheet. To assure that the external financial reporting is trustworthy, the US Financial Accounting Standards Board (FASB) and the European International Accounting Standards Board (IASB) develop standards and rules independently (IASB, 2010). Furthermore, the company is required to hire an outside independent agent, a certified public accountant, to go over the books and verify that the numbers indeed represent reality and performance. This external reporting function is parallel to the quality assurance (QA) function in a quality management system (QMS).

Jayaraman and Rivenson (2008) argue that healthcare is more complex than financial services and that information conveyed in external reports may lack the details required by internal reports and vice-versa. No modern business management team, however, relies on the external financial statement for day-to-day operations. Thus, firms have a parallel internal management accounting system providing detailed information that does not follow GAAP and seldom, if ever, is shared with the public. As in financial management, a QMS incorporates an internal information method that does not necessarily follow any external reporting standards but helps managers to control and to improve quality. To obtain valid and reliable information, we explore the analogy between financial and quality management to organize structure and to provide external reporting on healthcare quality for the public. We provide a brief quality management principles overview as the primary quality-information source. Then we take a closer look at the relationship between quality management and external reporting, known as QA. We provide a framework for measuring healthcare quality and suggest an organization to provide this information to the public.

1.3.2 Quality management and measuring quality

According to Juran (1986), the three quality management's principles are: quality planning; quality control and quality improvement (the Juran Trilogy). We discuss these three principles and look at them as quality information sources to support QA.

Quality planning: to improve healthcare, it is not sufficient to eliminate deficiencies, reduce medication errors and eliminate delays, et cetera, by just doing projects. The objective of quality planning (QP) is to design new products, processes and services without deficiencies (Juran, 1988). An example is the introduction of a new computer system for medication prescription and distribution support, to reduce medication errors. QP can be done in a structured manner, by systematically looking at healthcare markets, patient's demands and present healthcare specifications. The specific path to be followed and the information needed to get to a newly designed healthcare product are unpredictable, which means that the information generated in the quality planning process is specific, time dependent and closely related to unique questions. Therefore, this information is generally not useful for public reporting.

Quality control: this is the managerial process that provides stability, to prevent adverse change and to maintain the status quo (Juran and Godfrey, 1999). All employees, from the hospital floor workers to the CEO, exercise control. The only difference is the subject and control exercised by different groups. Healthcare professionals typically control products and processes related to the unit in which they work. Executives control budgets, revenues, costs, et cetera. The information needed to exercise control includes PIs that are well known in every hospital. Performance can be measured from financial, production, efficiency, logistic, personnel, quality and safety perspectives. Complications, postoperative infection rates and pressure sore incidence are popular. It takes effort to design an information system for controlling a specific department. Control of a nursing department, for instance, is different from control of a fully automated production line. Information related to quality control (QC) may be of interest to external stakeholders. Special attention is required when detailed QC information from varying departments is aggregated and simplified to fit public reporting using a single indicator.

Quality improvement: this is the most important function to establish an ongoing healthcare organization, which needs to be done via projects. In the Netherlands we have more than ten years experience with implementing Lean Six Sigma in healthcare (Van den Heuvel et al., 2006 and Does et al., 2006). From this experience, we know that information

required for quality improvement (QI) differs from project to project. After closing a project, much of the collected data can be skipped, because different data is required to preserve the improvements and to control the process. Information to perform QI projects is highly specific, costly to gather and only useful for a short period. Therefore, this source is unsuitable for providing healthcare quality information to share with the public.

1.3.3 Quality assurance

Quality assurance (QA) activities provide evidence to establish confidence that quality requirements will be met (Gryna et al., 2007). Juran pointed out that QC and QA have much in common (Juran, 1977). Both evaluate performance and both compare performance to targets. QA's main purpose is to verify that control is being maintained. Performance is evaluated after operations and resulting information is provided to the operating forces and others needing to know, including senior managers, corporate staff, regulatory bodies and the general public (Juran and Godfrey, 1999). Juran (1977) articulated the need for QA as an external function to complement the Juran Trilogy's internal management role. He also suggested that the financial function provides a useful managerial model for the quality function to emulate in job description and organization terms.

1.3.3.1 How to report quality information

There are several ways in which quality information can be presented. The first and most obvious are PIs. It is tempting to use PIs because they have a precise and concrete aura. These two supposed virtues will most likely lose their attraction after an aggregation process through different departments and several hierarchical layers. The natural response is to add more and also more detailed indicators. The extra indicators rarely provide more insight; on the contrary they are likely to produce more confusion. Additionally, based on Shewhart's work, we can demonstrate that hospitals with the same performance levels can produce different PI values owing to common cause variation (Mohammed et al., 2001). Comparing these hospitals in a league table format would, therefore, be meaningless because random variation is the only explanation for different scores.

The second way to present quality information is QMS certification. Compliance with the ISO-9000 standards, for example, provides confidence that hospital managers have a well-functioning QMS (Marquardt, 1999 and Van den Heuvel et al., 2005). Certification, however, does not guarantee healthcare quality.

The third way is accrediting the entire or parts of the healthcare organization. Accrediting a healthcare institute by the Joint Commission in the US or the NIAZ in the Netherlands, for instance, supports QMS's existence and functioning, and provides guarantees that professional standards are followed. A recent study demonstrated that implementing a surgical safety checklist containing various professional standards in six Dutch hospitals was associated with a significant reduction in surgical complications and mortality (De Vries et al., 2011). So, following standards enhances quality, and demonstrating that standards are met is a strong QA instrument. Certification and accreditation have in common that a third party verifies that an organization meets standards. The conclusion is fairly simple and transparent to the public: the organization does or does not comply with the standards.

1.3.3.2 Different healthcare QA information

Based on the input-process-output model and the quality definitions of Garvin and Juran, we identified five types of quality that can be measured to provide healthcare QA information (Boulding, 1956 and Garvin, 1984).

1. *Input quality* has to do with materials and professionals involved in healthcare processes. Well-trained personnel are expected to deliver better quality and a better hip prosthesis is expected to last longer. Serious quality problems related to prostheses have been described, for instance, in cardiac surgery (Graaf, 1992). Most QMSs pay attention to this type of quality and it can be best made explicit by an ISO certification (Van den Heuvel et al., 1998).
2. *Healthcare process quality* has to do with well-designed healthcare delivery processes and flawless performance. This quality can also be best made explicit by certification or accreditation. Unlike industry, the patient is an active participant in the healthcare production process. Therefore, some process PIs can provide relevant information. Admission and waiting times, rework and medication errors are process PIs that are relevant to future patients (Van den Heuvel et al., 2006). These indicators are not relevant to a person buying a product in industry; he is not interested in the way the production process performs provided that product quality is excellent.
3. *Healthcare product quality* has to do with the situation that exists at the moment healthcare delivery is completed. Has the treatment been performed according to professional standards? Were there adverse events or complications and treatment side effects? Because the patient is part of the healthcare process and the healthcare

product (e.g. owning a new hip), there is some overlap between healthcare process and healthcare product quality. The best way to establish healthcare product quality is to assess the patient's healthcare status after treatment is completed. Reporting healthcare product quality is best done using PIs. When healthcare product quality items are closely related to the healthcare process (proper medical and nursing procedures have been followed), certification and especially accreditation such as the Joint Commission Accreditation are also appropriate.

4. *Health gain* is quality which can be defined similarly to reliability used in engineering, i.e. the probability that a machine performs, for instance after repair or maintenance, as intended under specified operating conditions for a specified time. Reliability, therefore, is quality over time (Condra, 1993). Similarly, health gain could be defined as the therapy related reduction of complaints and limitations over time. So, if a patient gets a hip arthroplasty then the health gain would be how long and under what kind of limitations the patient lives with the (best possible) prosthesis implanted; the best possible operating procedures were followed and after that the best care was given, until complaints return. The next question would be: what are the scores of the hospital and physician I intend to visit and how do they relate to the best possible result. This would provide an excellent quality PI. Who wouldn't want to know this before going to a physician? Although highly relevant, this information is hard to collect. It requires ongoing, longitudinal yearly measurements that cost a lot of money. Aggregation is hardly possible because there is no value in averaging an excellent and a poorly performing physician. Furthermore, the information is prone to being outdated after every innovation, such as a new prosthesis or a new surgical procedure. We consider this information the most relevant of all five quality types but, unfortunately, the most difficult to obtain.
5. *Patient/client satisfaction* can be measured using questionnaires or interviews. This information can be obtained at reasonable costs and is especially relevant for improving services for patients/clients as well as for QP. The relevance to QA is limited except to provide service-quality information.

1.3.4 Reporting, relevancy and availability

We now provide a framework for reporting the different types of quality information of the previous section. The quality types are shown in the first column of table 1.1. In the second and third columns we show how healthcare quality can be measured and be made explicit for comparison by certification/accreditation and PIs respectively. In the fourth column we estimate the relevance to the public, and in the fifth column we estimate the availability of the healthcare information.

The number of "Xs" in Table 1.1 represents scores. One "X" in the certification/ accreditation or PI column means: it is not suitable to measure this type of quality and five "Xs" means: highly suitable. In the relevance and availability columns, one "X" means very low and five "Xs" mean very high.

In subsection 1.3.3.2 we identified five quality types that can provide healthcare quality information. Four are embedded in the QMS and information is available. Health gain is not or seldom part of the QMS and this information is scarce. Unfortunately, health gain information is also the most relevant to (potential) patients. We therefore have to realize that the most relevant quality information for patients is at the same time the least available.

1. Quality Type	2. Certification/ Accreditation	3. Performance Indicators	4. Relevance	5. Availability
Input quality	XXX	X	XXX	XXXXX
Healthcare process quality	XXXXX	XXX	XXX	XXXXX
Healthcare product quality	XX	XXXX	XXXX	XXX
Health gain	X	XXXXX	XXXXX	X
Patient/client satisfaction	XX	XXXX	XX	XXXX

Table 1.1: Reporting different types of quality, relevance and availability (from X = minimum to XXXXX = maximum).

Information tapped from the QMS has to be processed or at least aggregated to become relevant to the public. Two physicians, one excellent and the other poorly performing, demonstrate that aggregation deteriorates the information. Lingsma (2010, p.49) found that apart from differences in quality of care, the larger part of the observed differences between

hospital's quality PI scores can be attributed to random variation, patient characteristics that were not adjusted, residual confounding owing to imperfect case-mix correction, and registration bias. She concluded, therefore, that no outcome indicators currently used are suitable for ranking hospitals. Given these quality PI imperfections, one could imagine that QMS certification, like ISO-9001:2008 or healthcare system accreditation like the Joint Commission, might provide better transparency and assurance to the public than current quality PIs.

1.3.5 Organizing quality assurance

Developing valid, reliable and relevant information to measure quality is only one QA aspect. The other, also suggested by Pronovost et al., (2007), is to set up an organization to produce this information. We recognize five activities to organize QA:

1. *Determining which quality PIs are required to provide the most reliable and valid healthcare quality picture.* This is a challenge given the current PIs' poor validity and reliability. So, better PIs have to be developed. Furthermore, the process of inventing new PIs and updating existing ones has to be ongoing.
2. *Determining the rules regarding how each PI has to be measured.* In pressure ulcer cases, one could for instance exclude the child department or measure and report only departments (like the ICU) that are prone to pressure ulcers. Also, schemes for measuring pressure ulcers have to be designed to reduce registration bias. Guidelines are needed to determine which patients have to be included in order to reduce random variation. Finally, strict rules have to relate to case-mix adjustments.
3. *Measuring PIs by healthcare organization staff.* Preferably these measurements are performed and incorporated in the ordinary quality management process. Given the right PI's and rules, registration bias has to be reduced in this step.
4. *Verifying results and measurements independently comparable with certified public accountants' work.* A management letter can be produced that gives an impression of the total quality measuring process. This can be added to the final quality information publication.
5. *Aggregating and transforming quality information into an overall hospital score on one or more dimensions.* This process also needs specific guidelines, for instance on weighting factors and external verification otherwise some quality information might look useful but in fact is worthless.

The Dutch Healthcare Inspectorate covers the first two activities. They recommend PIs and guidelines for measuring them. There is debate between the Inspectorate and medical specialists about relevancy and validity, because the indicators are also used to judge physicians and hospitals. To prevent this counterproductive debate, service quality PIs have to be developed and defined by boards of independent experts, like the FASB and the IASB do for accounting rules. Indicators used to evaluate a hospital by the Healthcare Inspectorate will most likely differ from indicators that are valuable for informing the public. So, the ultimate goal producing and publishing an indicator has to be perfectly clear. To deal with the last two activities, verification and aggregation, independent organizations, comparable to accountancy firms in the financial world, are required. When we look at certification and accreditation, the situation is more mature. There are organizations engaged in developing QMS standards and safety management systems and these standards have been customized to healthcare (ISO, 2001). Also there are independent organizations that can execute certification or accreditation and provide specific certificates. Perhaps this situation is an additional and a strong argument for stimulating certification and accreditation as healthcare QA instruments.

1.4 Contributions and outline of the thesis

In the current debate about the escalating healthcare costs, it is typically assumed that there is a tradeoff between quality and cost of healthcare. This misconception is rooted partly in confusion about the definition of quality. Such misconception may impede progress in improving the management of healthcare and paralyze leadership. In section 1.2 we discussed quality management concepts and strategies for improving quality while halting the escalating costs of healthcare. In particular, we discussed how defining quality as “fitness for use” with the two subsidiary definitions of quality as “features” and as “deficiencies” conceptually help us understand the relationship between quality and costs. The “freedom from deficiencies” definition offers an opportunity for clinicians to redirect the focus to initiatives that will increase quality while reducing costs. Agreements on reinvestment priorities can be made before initiating a given project. This will enhance the participation and facilitate input from clinicians, which is essential for success of any project related to healthcare delivery. Section 1.2 is based on a paper, which was published in the *Quality Management Forum* (Does, Van den Heuvel, De Mast and Niemeijer, 2010).

In section 1.3 we support the view that public reporting on healthcare quality needs major improvements comparable to financial reporting. Information on healthcare quality can

be derived from the quality management system of the institution. Performance indicators related to health gain, which provide the most valuable information on healthcare quality for (potential) patients, have to be developed further. Independent organizations need to develop the right healthcare quality performance indicators and rules to measure them in a standardized way. Also, possibly other, independent organizations, comparable to accountancy agencies, are required to verify and validate the scores of healthcare institutions. It remains intriguing that we invest enormous amounts of money to verify financial information and we do not invest very much in verifying healthcare quality data, despite the fact that worldwide we spend billions on health care. Finally, we believe that certification and accreditation can play a more prominent role in public reporting on healthcare quality. This section is based on a paper, which appeared in the *International Journal of Health Care Quality Assurance* (Van den Heuvel, Niemeijer and Does, 2012).

The twentieth century saw an incredible development of professionalism in organizations. Besides the impact of technological advances, innovations in management structures and methods have resulted in the highly productive organizations of today. When the race for outperforming competitors on quality and efficiency gained momentum, companies started to copy each other's best practices. Consultants and management gurus quickly jumped in and started giving names to these methods: total quality management, just-in-time, business process reengineering, statistical process control, quality circles, lean manufacturing, continuous improvement, et cetera. Time has singled out the methods, principles, and approaches that really added value. While most approaches have been presented as panaceas at one time or another, time has shown that they are in fact complementary. In this thesis we will use the Lean Six Sigma approach.

Lean Six Sigma is not revolutionary; it is built on principles and methods that have proven themselves over time. It has incorporated the most effective approaches and integrated them into a full program. It offers a management structure for organizing continuous improvement of routine tasks, such as manufacturing, accounting, nursing, sales, and other work that is done routinely. Further, it offers a method and tools for carrying out improvement projects effectively. In an economy that is determined more and more by dynamics than by static advantages, continuous improvement of routine tasks is a crucial driver of competitiveness.

Optimizing healthcare efficiency appears to be an imperative. Healthcare process improvement can produce reductions in costs while increasing quality and thus producing the required efficiency improvements. Lean Six Sigma is a process improvement program developed in industry. However, in recent years it has also been applied by a number of healthcare institutions. Lean Six Sigma is a project oriented problem solving approach that deploys five rigorously followed problem solving phases - Define, Measure, Analyze, Improve, and Control (DMAIC). Program management consist a Lean Six Sigma director, program managers (daily management), and Lean Six Sigma master black belts (knowledge resources). Project management consist a champion (project owner) and a black belt or green belt (project leader), and the team members are experts and shop floor personnel.

The subject of Chapter 2 is to create actionable knowledge, making the definition of process improvement projects in healthcare delivery more effective. The study is based on a retrospective analysis of process improvement projects in hospitals, facilitating a case-based reasoning approach to project definition. Data sources were project documentation and hospital performance statistics of 271 Lean Six Sigma healthcare projects from 2002 to 2009 of general, teaching, and academic hospitals in the Netherlands and Belgium. Objectives and operational definitions of improvement projects in the sample were analyzed and structured in a uniform format and terminology. Extraction of reusable elements of earlier project definitions will be presented in the form of nine templates called generic project definitions. These templates function as exemplars for future process improvement projects, making the selection, definition and operationalization of similar projects more efficient. Each template includes an explicated rationale, an operationalization in the form of metrics, and a prototypical example. Thus, a process of incremental and sustained learning based on case-based reasoning is facilitated. The quality of project definitions is a crucial success factor in pursuits to improve healthcare delivery. By offering nine tried and tested improvement themes, related to patient safety, patient satisfaction, and to the business-economic performance of hospitals, we hope to contribute to this goal. Chapter 2 is based on a paper, which appeared in *Quality Management in Health Care* (Niemeijer, Does, De Mast, Trip and Van den Heuvel, 2011)

In the next chapters we describe two important generic projects in more detail. The empirical bases for these chapters are our own experiences in a number of hospitals we have worked for. Therefore, we have applied the longitudinal case study research method. This

method can be defined as an empirical study that investigates a contemporary phenomenon (Yin, 2009). Chapter 3 discusses an efficiency improvement project at a level I trauma center in the Netherlands, using measurements of inappropriate hospital stay from 2008 through 2010. The effect of reducing inappropriate hospital stay is to decrease the length of stay (LOS). But in contrast to LOS, inappropriate hospital stay does not depend on the complexity of the patients. The efficiency improvement project was carried out along the lines of the Lean Six Sigma program. The corresponding article appeared in the *Journal of Trauma* (Niemeijer, Trip, Ahaus, Does and Wendt, 2010).

Chapter 4 treats the subject of reducing overuse of diagnostic tests in hospitals. The data are from 2008 through 2011. As a result of the Lean Six Sigma project, the average number of diagnostic tests per treatment decreased significantly, without changing treatment guidelines. Patient's benefits are less exposure to potential adverse effects from the tests itself. This project has shown that Lean Six Sigma enables physicians to produce systematic and continuous quality improvement by reducing waste and costs. An article on this subject will appear in *Quality Engineering* (Niemeijer, Trip, Ahaus, Wendt and Does, 2012).

In Chapter 5 we study the usefulness of Lean Six Sigma for the development of a multidisciplinary clinical pathway for hip fractures in the elderly, with the aim of improving efficiency of care and reducing the length of stay. The related paper has been submitted to the *Journal of Evaluation in Clinical Practice* (Niemeijer, Flikweert, Trip, Does, Ahaus, Boot, Wendt, 2012).

Finally, in the last chapter we evaluate the results of the implementation of Lean Six Sigma in the second largest hospital in the Netherlands, one of the eight hospitals with a university medical department for education and research. This hospital started the implementation in 2007 and we are able to review the results of a five years' period. We will also discuss more detailed results obtained in the Department of Traumatology. The corresponding article has been submitted to *Quality Management in Health* Care (Niemeijer, Trip, De Jong, Wendt and Does, 2012).

Chapter

2

GENERIC PROJECT DEFINITIONS FOR IMPROVEMENT OF HEALTHCARE DELIVERY

This chapter describes a retrospective analysis of process improvement projects in hospitals, facilitating a case-based reasoning approach to project definition. The purpose of this analysis is to create actionable knowledge, making the definition of process improvement projects in healthcare delivery more effective. Data sources were project documentation and hospital performance statistics of 271 Lean Six Sigma healthcare projects from 2002 to 2009 of general, teaching, and academic hospitals in the Netherlands and Belgium. Objectives and operational definitions of improvement projects in the sample were analyzed and structured in a uniform format and terminology. Extractions of reusable elements of earlier project definitions are presented in the form of nine templates, called generic project definitions. These templates function as exemplars for future process improvement projects, making the selection, definition and operationalization of similar projects more efficient. Each template includes an explicated rationale, an operationalization in the form of metrics, and a prototypical example. Thus, a process of incremental and sustained learning based on case-based reasoning is facilitated. The quality of project definitions is a crucial success factor in pursuits to improve healthcare delivery. We offer nine tried and tested improvement themes, related to patient safety, patient satisfaction, and to the business-economic performance of hospitals. This chapter is based on Niemeijer, Does et al. (2011).

2.1 Introduction

Innovation in medical science, including innovations in treatment protocols, medical equipment, and pharmaceuticals, is perhaps the first connotation with the topic of healthcare improvement. This chapter, however, addresses the improvement of healthcare by improving its delivery. Healthcare delivery is about the operating routines in hospitals, including primary patient processes, and medical and nonmedical support processes. Characteristics of these processes, such as their efficiency and reliability, determine important performance dimensions of healthcare, such as patient safety (a direct outcome of failures in the processes), waiting times and delays (determined by process flow dynamics), capacity and throughput (resulting from staffing and efficiency of work procedures), and ultimately, patient

satisfaction, cost, and quality and timeliness of medical care. The improvement of all of these dimensions is generally seen as urgent.

The improvement of processes is the subject of a discipline which goes back to scientific management (Wren, 2005), and has resulted in such manifestations as total quality management, business process reengineering (Hammer, 1990), business process management (Van der Aalst and Van Kee, 2004), theory of constraints (Davies et al., 2004) and Lean Six Sigma (De Mast et al., 2012). These approaches have been well studied in the academic literature, and tried and tested first in industry, and later also in service organizations. Recent years witnessed a growing interest from healthcare in these approaches (Young et al., 2004; Marshal, 2009; Langabeer et al., 2009; De Mast et al., 2012). Our research concerns Lean Six Sigma in particular. We have reported our experience with its implementation in healthcare organizations in Van den Heuvel et al. (2006); Van den Heuvel (2007); Bisgaard (2009), and De Mast et al. (2012). Other examples can be found in Thomerson (2001); Lazarus and Stamps (2002); Sehwail and DeYong (2003); Fischman (2010); Yamamoto et al. (2010); Dellifraine et al. (2010); Kuo et al. (2011).

Improvement initiatives in the paradigm of process improvement are typically structured as a project organization, with improvement projects as the main units of activity. The literature on project management recognizes lack of precision and quality of project definitions as one of the most important factors for project failure (Morris, 1987; Partington, 1996), and our objective is to offer actionable insights, which help healthcare professionals become more effective in project selection and definition. We aim to extract reusable elements from a large collection of reports of past project definitions, and make these accessible for practitioners in the form of a case-based approach. We identify generic themes that lend themselves as topics for such projects, and we present these generic themes in the form of templates for project definition. The relevance of these contributions is proposed to be their facilitation of program management by offering tried and tested themes for improvement projects and their facilitation of project leaders by offering worked-out templates for defining their projects.

2.2 Methods

One way to help practitioners in defining their improvement projects is by discovering principles in project definition, and offering these in the form of rules and guidelines. Unfortunately, project definition is a rather ill structured task, and it is difficult to offer strong and operational principles. Emerged in response to such situations, and as a complement to rule-based prescriptions, case-based reasoning (CBR) is a paradigm for problem solving and decision making that is not based on knowledge framed in rules or principles. In CBR, agents facing a new task or problem deal with it, not by following rules, but by finding a similar past case, and reusing its lessons in the new situation. A physician applies CBR when he or she thinks: "I have seen a patient like this before," and uses his or her recollection of these earlier cases in dealing with the new case. CBR was devised by artificial intelligence researchers (Slade, 1991; Aamodt and Plaza, 1994) and, after some early publications in the late 1980s, has recently been making a revival in medicine (Holt et al., 2006; Dussart et al., 2008). The diversity of CBR applications in medicine includes diagnosis, classification, planning and tutoring, and ranges from psychiatry and epidemiology to clinical diagnosis medicine (Holt et al., 2006). We offer, in this work, a case-based approach that helps practitioners in defining their improvement projects. Such an approach consists of a substantial collection of past cases, and a procedure that helps the practitioner retrieve cases pertinent to the project at hand, thus making the collection accessible for practitioners. We explain below the details of our collection of cases, the way we analyzed them, and how we propose to make the collection accessible to practitioners.

Our collection of cases consists of 271 process improvement projects, carried out at some ten hospitals in the Netherlands and Belgium. Table 2.1 gives an overview. These projects vary along key dimensions such as type of department (Emergency Room, Operating Theatre, Nursing Department, Planning and Control, Human Resources, Facilities, Outpatient Clinic), type of organization (general, teaching, and academic hospitals of various sizes), scope, and size (benefits ranging from €20,000 to €2,750,000). Staff employees ran 45% of these projects, managers 30%, nurses 20%, and physicians 5%. Lean Six Sigma project leaders are called black belts or green belts.

Hospitals and number of Lean Six Sigma projects in the Netherlands (NL) and Belgium (B)				
Hospital	**City**	**Type**	**Beds**	**Projects**
Lange Land Hospital	Zoetermeer (NL)	general	245	9
Red Cross Hospital	Beverwijk (NL)	general	384	18
Deventer Hospital	Deventer (NL)	teaching	477	14
Virga Jesse Hospital	Hasselt (B)	teaching	567	29
Canisius Wilhelmina Hospital	Nijmegen (NL)	teaching	635	37
Reinier de Graaf Healthcare Group	Delft (NL)	teaching	881	28
Erasmus Medical Center	Rotterdam (NL)	academic	1221	19
University Medical Center	Groningen (NL)	academic	1339	112
Others	-	general	-	5

Table 2.1: Hospitals and number of Lean Six Sigma projects in the Netherlands (NL) and Belgium (B)

All of these projects followed the model of the Lean Six Sigma methodology (De Mast et al., 2012). In this approach, projects are managed rigorously according to the five phases of Define-Measure-Analyze-Improve-Control (DMAIC). Each phase is completed upon the delivery of specific milestones. Thus, the status and progress of projects is assessed in a standardized way within departments and across the entire organization, much like the stage-gate approach outlined by Cooper (1990).

The project selection and definition are done, in Lean Six Sigma, in the first two phases, Define and Measure, in which a project's objective is clarified by specifying quantitative and measurable indicators called Critical To Quality characteristics (CTQs). A commonly used technique is the CTQ flowdown (De Koning et al., 2007). This tool makes explicit the rationale underlying the project by showing hierarchically how CTQs relate to higher level concepts such as an organization's performance indicators and strategic focal points. Read downward it associates CTQs to measurements by providing operational definitions. The CTQ flowdown results in a measurement plan, which operationalizes a project's objectives (Figure 2.1). In the Analyze and Improve phases, the data collected according to the measurement plan serve as a basis for process diagnosis and improvement

actions; in the Control phase these improvement actions are integrated in line and process management.

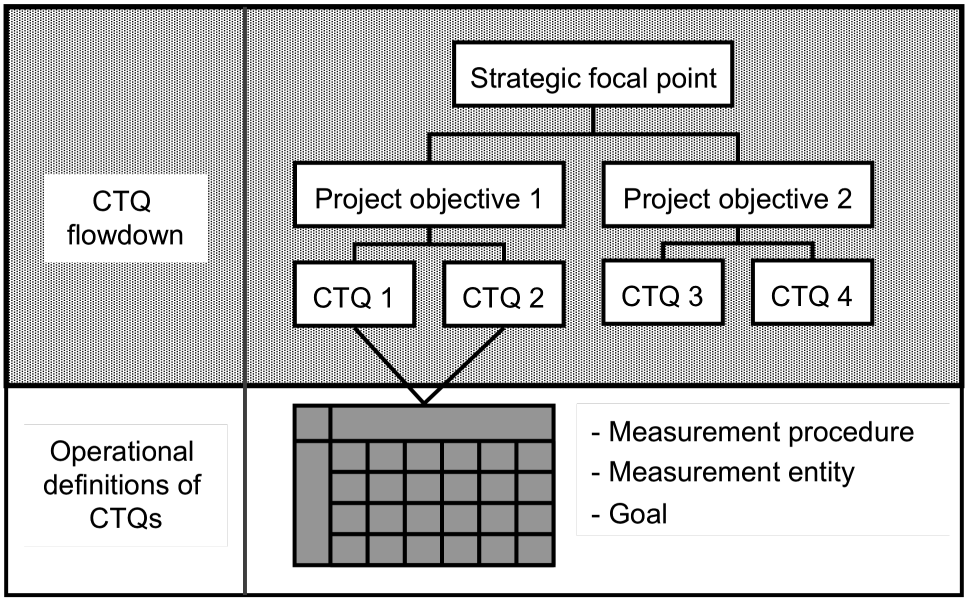


Figure 2.1: The two elements of Lean Six Sigma project definitions: CTQ flowdown and operational definitions

Part of the description of each of the 271 projects in our sample was a project definition, including at least:

- A business case, specifying the business rationale for the project.
- A (macro level) process description.
- The project's CTQs.
- A description of the measurement procedure for each CTQ.

Searching for a form in which the 271 cases can be made accessible and useful for practitioners, we reason as follows. Past cases offer lessons at various levels of generality, ranging from lessons highly specific to a case to very general lessons. Following Smith (1994), we think that the most useful insights occupy an intermediate level of generality. Very general lessons tend to be weak and nonoperational, while highly situation-specific lessons have just a small range of applicability (this is Newell's power/generality trade-off, cf. Newell, 1969). For this reason, we removed from the 271 project definitions the project-

specific details; deprived of these specifics, many project definitions have similar CTQ-flowdowns (ignoring differences in wording). This provides us with an organizing principle that helps us to make approaches extracted from the case base accessible for practitioners. Grouping cases with identical CTQ-flowdowns (after removal of situational specifics), we found nine groups, for each of which we chose a representative or prototypical case consisting of a CTQ-flowdown and operational definitions. Thus we arrived at nine templates, which we refer to as generic project definitions. They are proposed to serve as exemplars, which project leaders may use in defining their own projects. These nine templates make accessible the approaches of 271 project definitions for reuse in future projects, and could inspire program managers in identifying candidate themes for improvement efforts.

Note that the nine templates are not intended as a typology or taxonomy of projects, with the claim of completeness that these terms imply, as in Shenhar (1998) or Cooper and Kleinschmidt (1995). Combining similar cases into nine templates serves the mere purpose to make experience accessible to practitioners without getting lost in situation-specific detail (cf. the use of *generalized cases* or *generalized episodes* in other CBR systems (Aamodt and Plaza, 1994)).

We propose that practitioners apply the templates in the following manner. Presented with the task of making a project definition for a process improvement project, the project leader matches a tentative and unstructured notion of the project's objectives with the descriptions of the nine templates and the associated CTQ flowdowns. If he or she finds a template bearing sufficient similarity, he or she modifies the template's CTQ flowdown and operational definitions to the specific situation at hand. The resulting project definition is evaluated during a project review, and improved if necessary. Thus, the retrieve, reuse and revise steps generally followed by CBR systems are implemented (Aamodt and Plaza, 1994). Note that the proposed approach does not offer a strong method for the *retain* function, typical of many CBR applications. This function concerns the addition of a new case to the case base if it is sufficiently novel or has value for reuse in future cases. In the proposed approach, there is no updating of the case base beyond the updating done by Niemeijer, Does et al. (2011).

2.3 Nine generic project definition templates

We identified nine generic project definition templates. The numbers of projects in our sample per template are denoted within brackets

1. Reduce costs by improving productivity of personnel (65)
2. Reduce costs by improving utilization of equipment/facilities (34)
3. Reduce costs by improving purchasing processes (10)
4. Reduce costs by reducing unnecessary use of resources (21)
5. Reduce costs by reducing inventory (9)
6. Improve safety by reducing complications and incidents (10)
7. Increase revenue by improving registration (30)
8. Increase revenue by increasing the number of admissions (41)
9. Increase revenue by increasing capacity (51)

Below, we elaborate these nine generic templates, briefly discussing their objectives and offering suggestions for operational definitions. We also present a prototypical example for each template. Most of these examples are available in generally accessible publications.

Project template 1: Reduce costs by improving productivity of personnel

Often, departments and teams are overstaffed because of poor planning. This is particularly alarming given the fact that approximately sixty to seventy percent of the annual budget of a hospital consists of costs related to personnel. Projects improving staffing generally focus on four CTQs: Time lost on irrelevant activities; Processing time per task (cycle time); Idle time due to overstaffing; and the discrepancy between the weight of a task and the functional level of the person who executes it (Figure 2.2).

Example 1. In the University Medical Center Groningen management suspected an imbalance of supply and demand of nurses in the current staffing of nursing departments. After careful debate and based on the core principle of carefully selecting projects that are clearly aligned with organizational strategy, management selected nursing efficiency in the maternity ward as a pilot project for the first wave of the Lean Six Sigma rollout.

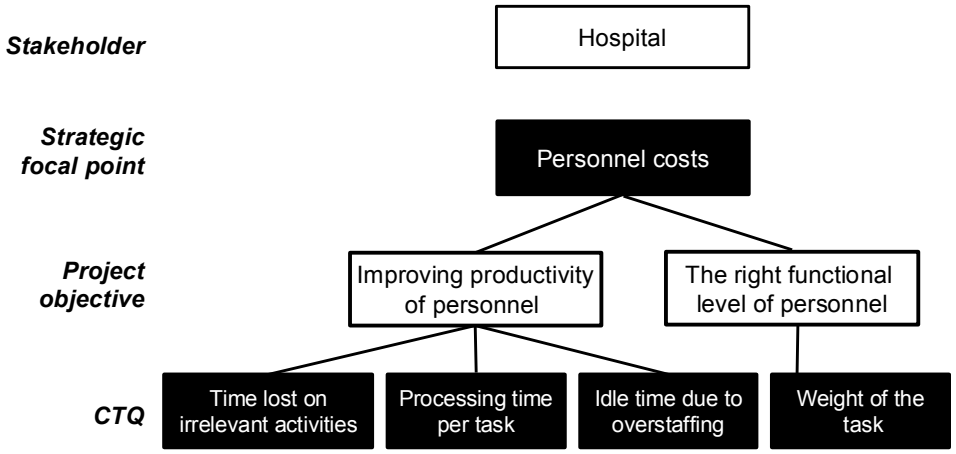


Figure 2.2: The CTQ flowdown for projects improving productivity of personnel.

The analysis of activities performed by the nurses showed that more than 30% of their time was used for administrative tasks and team meetings. Lack of structure in formal and informal meetings was identified as one major reason for wasted time. Another was the use of multiple forms for related information causing unnecessary and often frustrating redundancy.

The black belt (i.e. the project leader in Lean Six Sigma terminology) proposed to bring more structure to meetings, to redesign and streamline the paperwork, and to remove redundancy. As a secondary benefit, greatly appreciated by the nurses, time was freed up for training, medical-ethical discussions, and other professional development. The annual cost of the nursing department was reduced by an estimated €147,000. The study (Wijma et al., 2009) also showed that further cost reductions of €53,000 were possible if temporary workers were used only if necessary. Note that at this hospital there are about 40 different nursing departments. With a potential savings per department of about €200,000, this means substantial amounts of cost reductions and quality improvements.

Project template 2: Reduce costs by improving utilization of equipment/facilities

In hospitals available facilities and equipment are often only partially utilized, even at peak hours. Partly, items are underutilized because they are unavailable (due to maintenance, cleaning or repair), and partly because they are missing. As a result, more items are needed, and staff time is lost searching for missing items. The typical CTQs for this template of projects are (a) The percentage of items that are unavailable at a given time; (b) The percentage of items that are missing at a given time (Figure 2.3).

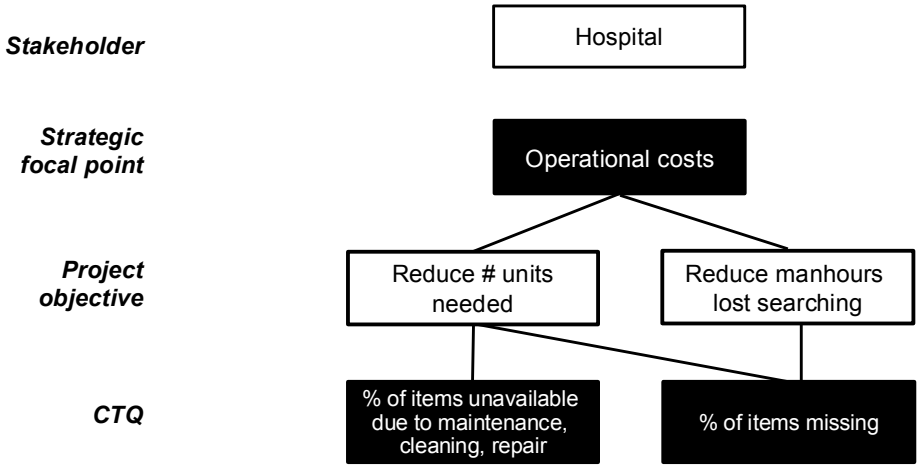


Figure 2.3: The CTQ flowdown for projects improving the utilization of equipment and facilities.

Example 2. In the Medical Spectrum Twente hospital in Enschede (NL) one of the projects focused on the reduction of total costs in the processes of buying and maintaining infusion pumps (Kemper et al., 2009). Departments have their own infusion pumps. If occasionally more pumps are needed than available, employees spend time tracing one, since the hospital lacks a track and trace system. The maintenance of infusion pumps is not monitored at all. Therefore, it is unclear if the current maintenance level meets regulations related to patient safety. The most important improvement actions were:

A. Standardization of the pumps (resulting in a yearly reduction of depreciation of about €16,000);
B. Introduction of a scan system for tracking and tracing the infusion pumps, resulting in an extra reduction of depreciation of about €16,000 yearly. Note that an additional benefit of the scan system is that employees are expected to spend less time

searching. A similar black belt project in the University Medical Center Groningen demonstrated these track and trace costs to be about €175,000 per year.

Project template 3: Reduce costs by improving purchasing processes

Hospitals spend a lot of money acquiring goods, services and hiring personnel. A revision of the purchasing process may result in savings due to cheaper purchase prices or more efficient manpower (Figure 2.4).

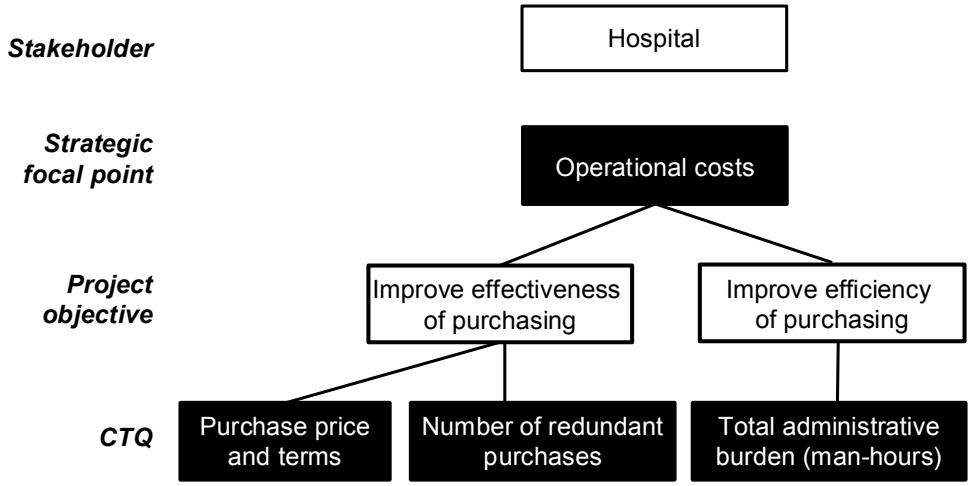


Figure 2.4: The CTQ flowdown for projects improving purchasing processes.

Example 3: In 2003, the Red Cross Hospital in Beverwijk (NL) spent more than €1,000,000 on temporary personnel. There was no procedure for hiring temp workers, and departments all had their own contacts with temp agencies. Every agency used its own worksheet and it was very hard to verify invoices. This situation led to a substantial administrative workload. Once reviewed, a substantial number of invoices turned out to have discrepancies, mostly to the advantage of the temp agency. The project focused on both the cost of hiring temp workers and the number of correct invoices (Van den Heuvel et al., 2004). The following actions were chosen to diminish the number of mistakes: a standardized worksheet for every temp worker was introduced; requests for temp personnel were centralized; an administrative system to check the irregularity bonus and the invoice was introduced and the number of temp agencies was reduced.

Project template 4: Reduce costs by reducing unnecessary use of resources

One of the drivers of operational cost is poor use of materials and energy, but also unnecessary consults in for example diagnostics. The used volume and the cost per unit determine total cost of resources. A typical CTQ in this template could be "Number of unnecessary used units (material/energy) or consults" (Figure 2.5).

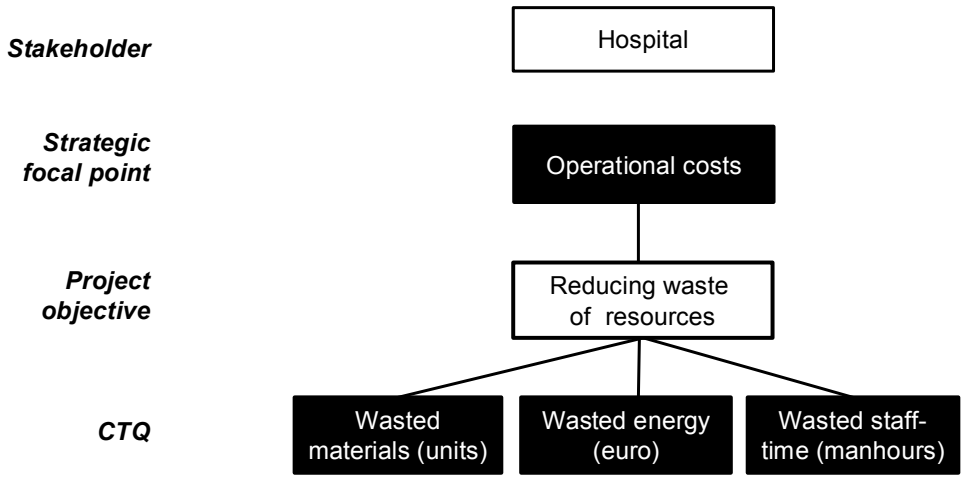


Figure 2.5: The CTQ flowdown for projects reducing unnecessary use of resources.

Example 4: At the departments of internal medicine, pulmonology, urology and orthopedics of the University Medical Center Groningen about 1,300 patients received intravenous antibiotics in 2008. Data showed that 40% of these patients could have switched earlier to substantially cheaper oral medication. A protocol was developed specifying when a patient could switch to oral medication; this new protocol resulted in annual savings estimated at €70,000. Another example can be found in Chapter 4.

Project template 5: Reduce costs by reducing inventory

Inventory brings about costs related to cost of capital, obsolescence, damages, and storage. While ensuring a reasonable low rate of out-of-stock occurrences, the number of items in stock can be reduced by avoiding the purchase of items which are obsolete immediately or shortly after they have been purchased, by lowering the safety stock level (the number of items left when new supplies are ordered), and by rationalizing the cycle stock level (the quantity of items bought when resupplying) (see Figure 2.6).

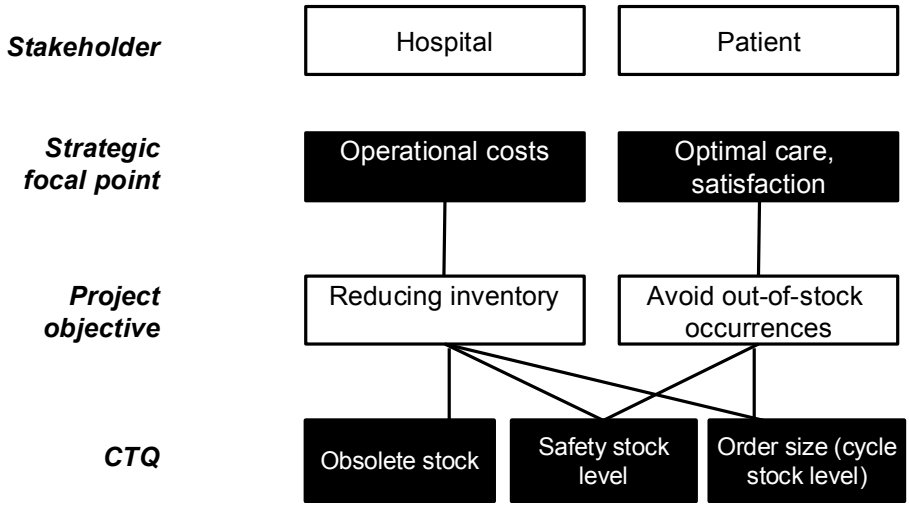


Figure 2.6: The CTQ flowdown for projects reducing inventory.

Example 5: Nursing departments of the University Medical Centre Groningen are daily supplied with standard materials. Occasionally there are special patients requiring nonstandard material. These are specially ordered, with opportunities to make mistakes. A project at the internal medicine nursing departments aimed at reducing wasted nonstandard materials. The minimum order size often exceeded the required number, leading to superfluous materials (about 20% of nonstandard material, or €84,000 per year for the internal medicine wards). The data were collected in the wards, since the logistical software system was not up to the task of recording returned products. A benchmark study indicated that some nursing departments wasted hardly anything. Their strategy was not to order nonstandard products, but to take (or buy) these from departments where such products are standard.

Project template 6: Improve safety by reducing complications and incidents

Complications and incidents affect patient safety, patient satisfaction, and financial losses incurred by the longer length of stay (Figure 2.7).

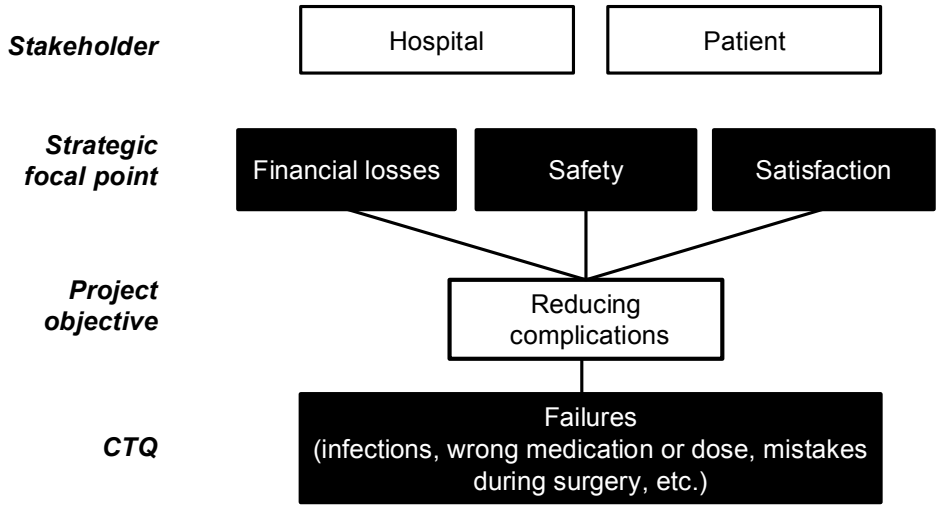


Figure 2.7: The CTQ flowdown for projects reducing complications.

Example 6: Based on a report of physicians (Bruijne et al., 2007), the Dutch authorities announced 1700 potentially avoidable deaths per year in Dutch hospitals, and 76,000 patients suffering potentially avoidable permanent injury. Just to compare: fatal traffic accidents in 2008 in the Netherlands were less than 800. A black belt project at the University Medical Center Groningen started in January 2008 with the goal of reducing the rate of post-operative wound infections (POWI) by 50%. Infections were registered in patient files, but summaries were rarely obtained. These summaries proved to be essential for creating awareness about the problem; POWI rates for some patient groups proved to be above 20%. Awareness is a key factor, as disregard of hygiene standards is a major cause of POWI. The black belt identified a large number of potential influence factors, and based on evidence from literature, measurements, and interviews with experts, the most important ones were selected. This resulted in improvements of the air conditioning in the operation theatres and storage rooms, better temperature control of patients, and dedicated training for surgeons and operation personnel. A scheme was put in place for annual auditing of compliance to these standards.

Project template 7: Increase revenue by improving registration

A hospital does not only receive invoices from its suppliers, it also issues invoices to patients and insurance companies. It may happen that some of the invoices are refused or delayed due to mistakes, resulting to missed or delayed revenue, and increasing the administrative burden (Figure 2.8).

Example 7: The Red Cross Hospital in Beverwijk (NL) issues approximately 250,000 invoices per year to patients and insurance companies. Of these, about 9% are refused and sent back due to mistakes by the hospital. After an in-depth study of the process by a green belt team, a number of problems were identified and process improvements implemented. The team was able to reduce the defect rate by 90%. This translates into a saving exceeding €150,000 per year.

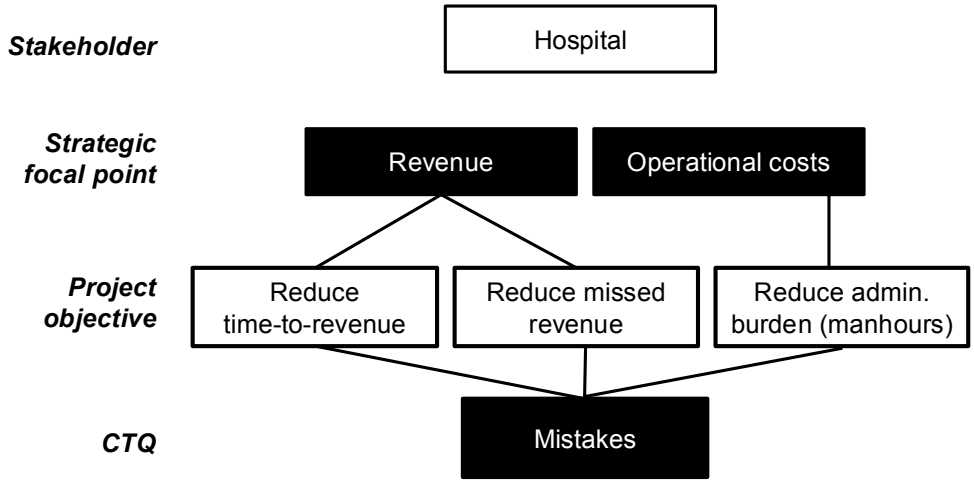


Figure 2.8: The CTQ flowdown for projects improving registration.

Project template 8: Increase revenue by increasing the number of admissions

Hospitals earn money by admitting and curing patients. Treating more patients provides more income for a hospital and at the same time may reduce waiting times for patients before they are treated. Shortening the length of stay can increase admissions (under the assumption that there is sufficient demand) (see Figure 2.9).

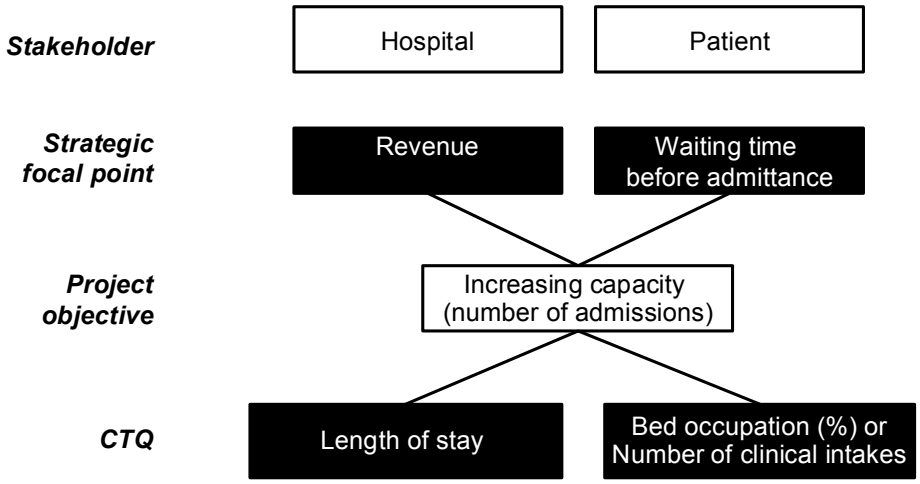


Figure 2.9: The CTQ flowdown for projects increasing number of admissions.

Example 8: The University Medical Centre Groningen is a level 1 trauma center in the northern part of the Netherlands. Seventy percent of all the admitted patients on the trauma-nursing department (TND) are acute patients who are admitted directly after trauma. Due to the relatively high bed occupation, in 2006 and 2007, it was not always possible to admit all trauma patients on the TND. A full account of this project may be found in Chapter 3.

Project template 9: Increase revenue by increasing capacity

The last template of projects aims to increase the revenues of a healthcare institution by increasing the capacity of resources. Part of this issue is often measured in terms of "throughput time", the time span from the request of a service to the moment the service is fully delivered. Throughput time can be further broken down into waiting time, processing time and rework time if certain steps have to be redone. To measure the resulting efficiency we compute the number of productive hours and the number of items produced (see Figure 2.10). As in template 8 this kind of projects is initiated because of long admission time.

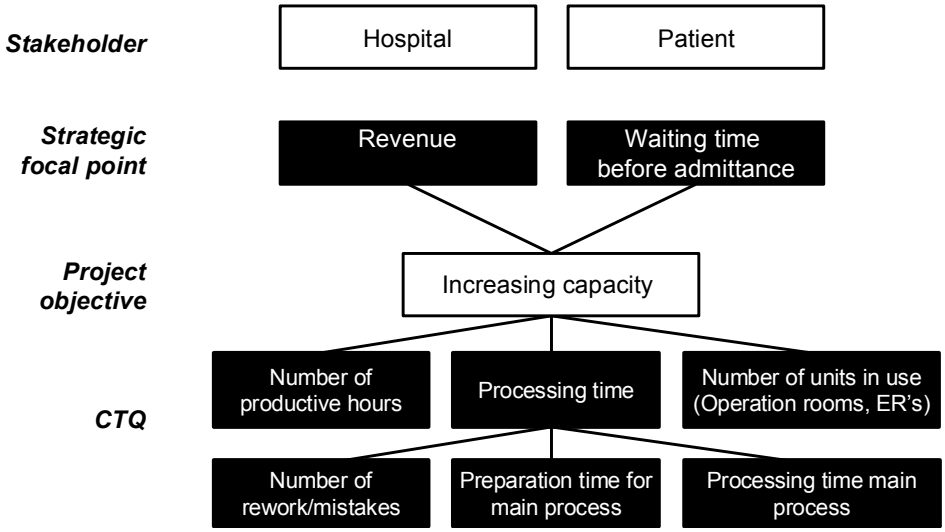


Figure 2.10: The CTQ flowdown for projects increasing capacity.

Example 9: Capacity problems are standard in hospitals. In our practice we have run projects aimed at improving the usage of operating theatres, among others. Hospitals like the Canisius Wilhelmina in Nijmegen, the Red Cross in Beverwijk and the Virga Jesse in Hasselt participated in a benchmark study among thirteen hospitals (Does et al., 2009). This study focused on starting on time, and utilizing all available time. The official start time is most of the time around 8:00 am. Data collected in the Measure phase showed that the average start time was about 30 minutes too late. For a hospital with 20 operating rooms and an average of 250 days in a year, this adds up to 2,500 lost hours that could be used for productive work. Operating theatres in a modern hospital are capital-intensive units staffed by highly skilled and thus expensive staff.

2.4 Discussion and conclusion

In the case-based reasoning paradigm, a profession may learn by organizing practical experience in such a way that it provides useful guidance for future efforts. We contribute to the pursuit that seeks to improve healthcare delivery by improving operating routines in hospitals. Project selection and definition are difficult but crucial tasks in this pursuit. We

offer nine generic themes for process improvement projects, and provide standardized templates intended to provide useful guidance to project leaders.
Our sample of projects does not qualify as a representative sample. In the CBR pursuit, representativeness of the sample of cases is irrelevant, as one's aim does not involve the extrapolation of sample results to conclusions for a population. Our sample is suitable as a basis for actionable and case-based guidance for practitioners, as long as one keeps in mind that we do not claim that the relative frequencies of the nine templates can be generalized beyond our experience, and that the proposed categories are not claimed to be unique or complete. Most of the projects were conducted in the specific context of the Dutch healthcare system; further research in other healthcare systems is likely to expand the knowledge base. On the other hand, the variety and size of our case base make it a rather unique collection.

In an earlier analysis of Lean Six Sigma healthcare projects (Does et al., 2009) identified six templates, based on 100 projects (all of which are included in the current sample). The 171 additional projects have greatly sharpened the templates, and they have expanded the scope of the case base. The authors continue updating the collection when needed. At the time of writing of this chapter, about 200 new cases had been reviewed from the hospitals mentioned in Table 2.1 and Martini Hospital in Groningen, Westfriesgasthuis in Hoorn, University Medical Centers in Amsterdam and Utrecht and Beatrix Hospital in Gorinchem. No additional templates were added, since for each of these 53 new cases a useful template was found among the nine proposed in the article of Niemeijer, Does et al. (2011).

Another word of caution is that situations differ across hospitals, and although schemas for stereotypical situations are a powerful resource in problem solving and decision making, they should not be applied uncritically and without considering modifications to situational circumstances.

The Lean Six Sigma literature (De Mast, 2007) suggests that process improvement projects should be conducted throughout the entire organization and lead by professionals intimately involved in the processes. Problems in healthcare are numerous, highly detailed, and typically hinge on knowledge that is local in nature; these factors make it, for many problems, ineffective to entrust them to external specialists, staff functionaries or consultants. This, however, means that healthcare providers, physicians, and in particular nurses need to assume a leadership role in executing Lean Six Sigma projects. For these professionals, the

availability of tangible and actionable knowledge may substantially lower the threshold for embracing initiatives at improving healthcare delivery. This work offers case-based knowledge for project selection and definitions, in the form of templates for commonly encountered improvement opportunities, to complement the rule-based knowledge that the Lean Six Sigma methodology embodies in the form of guidelines and prescriptions such as the before mentioned DMAIC procedure. These generic project templates have clear and explicated rationales. Most are directly related to drivers of operational cost, while some are related to revenue, patient safety and patient satisfaction.

Chapter

3

IMPROVING THE LENGTH OF STAY OF PATIENTS

This chapter based on Niemeijer, Trip et al. (2010) describes that Lean Six Sigma is an effective method to reduce inappropriate hospital stay, thereby improving the quality and financial efficiency.

3.1 Introduction

Healthcare and welfare expenses in the Netherlands amounted to €72.2 billion in 2006 (Statistics Netherlands, 2007), which is 13.7% of the gross domestic product, or €4,417 per capita. The cost of care increases every year and would still be higher if politics and insurance companies were not limiting the budget. Because 45% of the healthcare budget is spent by hospitals, they must try to find acceptable strategies to reduce cost without loss of quality. At the same time, however, they will grow because of the ageing population, entailing a further increase in expected lifetime and a larger proportion of older people with multiple co-morbid diseases. Because the healthcare cost per person increases exponentially from the age of 50 (Meerding et al., 1998), cost reduction efforts are really necessary.

At the same time, healthcare organizations are searching for ways to deliver higher quality of care (e.g., decrease in the number of defects and shorter length of stay). The length of stay (LOS) is often used as an outcome measurement in research. Managers and politicians have used it as a performance indicator of efficiency (Simoens and Hurst, 2004; Clarke, 1996). It is mostly applied as a financial indicator of costs, but can also be defined as a process, service or clinical indicator of the quality of care (Vanhaecht and Sermeus, 2003). Factors influencing LOS include the injury/disease, the organization of care, the availability of hospital beds, and the chain of care in which patients are being transferred from the hospital to, for example, a nursing home (Clarke, 2002; Brasil et al., 2007). In the last decade, many hospitals have chosen to organize disease-specific clinical pathways resulting in both cost reduction and a decrease in LOS for specific groups of patients (Rotter et al., 2008; Müller et al., 2009).

This chapter describes an efficiency improvement project, using measurements of appropriate hospital stay (the Dutch version of the Appropriateness Evaluation Protocol (D-

AEP), cf. Panis et al., 2002). Reducing inappropriate hospital stay implies a decrease in LOS. Note that inappropriate hospital stay is not related to the complexity of the patients. The efficiency improvement project was carried out along the lines of the Lean Six Sigma (LSS) program, a relatively new methodology for reducing costs and improving the quality of healthcare. LSS is a widely applied program for company-wide quality improvement developed in industry but more recently also successfully applied in healthcare (Frankel et al., 2005; Van den Heuvel et al., 2006) and trauma care (Parks et al., 2008).

3.2 Patients and methods

The University Medical Center Groningen (UMCG) is the only level I trauma center in the northern part of the Netherlands with 10,000 employees and 1,339 beds. The hospital is the second largest in the Netherlands. In 2007, the board introduced a strategic plan with focus on reducing costs, improving the quality of care, and facilitating the development of healthcare innovations. Based on the experiences of a few smaller hospitals in the Netherlands (Does et al., 2009) with LSS, the methodology was selected to realize these goals. The Traumatology ward (30 beds) is one of five units of the surgical clinic at the UMCG. The surgical clinic is an autonomous subdivision, allowing a flexible admission of patients from the five units (with a total of 115 beds). Pediatric patients (younger than 18 years) were admitted to the pediatric clinic, and adult trauma patients with severe head, neck, and brain injuries were admitted to the clinic of Neurosurgery.

The aim of the LSS project was to reduce the mean LOS, to create more admission capacity and reduce costs. LSS is a combined approach of Lean Thinking and Six Sigma (De Koning, 2007). Lean Thinking (Womack, 2003) provides analysis tools and techniques with the aim of mapping out and removing inefficiencies (queue times, capacity bottlenecks, and quality defects). Six Sigma offers an organized, parallel organization structure to reduce variation in organizational processes by combining improvement specialists, a structured method, and performance metrics with the aim of achieving strategic objectives (Schroeder et al., 2008). The LSS project leaders are recruited from within the organization and trained as improvement specialists, to become Black Belts or Green Belts (GBs). LSS projects follow a rigid framework, called the five phases DMAIC (Define, Measure, Analyze, Improve, and Control) roadmap, see Figure 3.1 (De Mast et al., 2012).

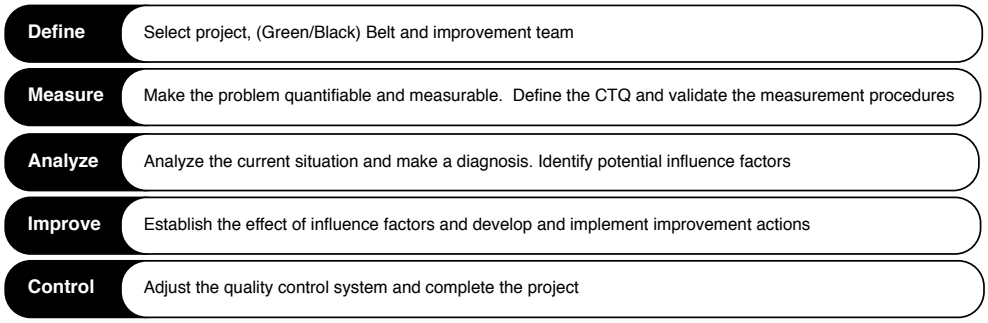


Figure 3.1: The five phases DMAIC roadmap (de Mast et al., 2012).

This particular LSS project started in February 2008. A SIPOC (supplier-input-process-output-client) analysis (Parks et al., 2008; De Mast et al., 2012) was the start, to give a broad outline of the process on a macro level, serving as the starting point of the process description on the micro level. The goal of the Measure phase is the translation of the problem into measurable indicators, called CTQs (Critical to Quality) (De Koning and De Mast, 2006 and 2007). The CTQs of this project were LOS, bed occupation, and number of admissions. The targets were as follows: a LOS as short as possible; a bed occupation of 90% with 2 acute beds available on each day; and a maximum number of admissions.

First, we collected retrospective data from 2006 to 2007 of all the admissions to the Trauma Ward (TW). The second set of data was collected from a prospective sample survey. During a 70 days period (February-April 2008), the following information was collected for all admitted trauma patients: day of (emergency) admission, diagnosis/kind of operation(s), day of discharge, and the bed occupation at 10 am and 4 pm. The LOS measurements also included a value stream map (De Mast et al., 2012) of the patients' process in which all separate steps from admission to discharge were measured to discover the factors that had a high impact on LOS. Reducing LOS was not the ultimate goal; we wanted to reduce any unnecessary (and potentially harmful) LOS. To identify the proportion of the inappropriate hospital stay, we used the D-AEP that is based on the original Appropriateness Evaluation Protocol (US-AEP). The US-AEP has already proven to be useful in the United States and other European care settings. The D-AEP was tested on different medical departments (Surgery, Neurosurgery, Internal medicine, and more) and proved to be valid (κ=0.76) and

reliable (κ=0.84) to assess the (in)appropriateness of hospital stay (Panis et al., 2002). Appropriate hospital stay refers to all inpatient stay during which continuous and active medical, nursing, or paramedical treatment is required, which cannot be provided through extramural care, day care, or outpatient care (Panis et al., 2002). Table 3.1 shows a short description of the D-AEP.

The green belt (a Physician Assistant) and two specific well-trained nurses not directly involved in daily patient care, measured the (in)appropriate hospital stay at the pre- and post-intervention period. The data from the prospective sample survey of 70 days (2008) provided us with information on daily bed occupation and LOS. The bed occupation at 10 am (after discharge) shows the capability to admit emergency patients to the TW. During 1 week we assessed each day whether the trauma patients stay at the TW was actually necessary. In another week we followed all newly admitted trauma patients during their time in the hospital, assessing again the appropriateness of their stay. To avoid possible Hawthorne effects, the results were only communicated to the care providers 2 months after the measurements, during the "Improve" phase of the DMAIC roadmap.

Criteria for appropriate clinical stay	**Such as**
Threatening situations, requiring clinical care	Spinal cord lesion, circulatory and/or respiratory disorders
Care, requiring clinical control or observation	Surgical procedure, wound and drainage care
Monitoring	Close medical monitoring by a nurse
Infusion and/ or medication	IV administration of fluids and/or nutrition
Nursing care	Isolation of the patient, endotracheal suction
Assessment of appropriate stay is not possible	Reasons, (to be specified)……..
Reasons for inappropriate clinical stay	**Such as**
Further clinical stay required	Delay in interventions for further treatment
No further clinical stay required	Delay due to discharge procedures
Inappropriate stay due to the patient or family	Lack of (persons for) informal care
Inappropriate stay due to care environment	Patient is waiting for transfer to other care facility

Table 3.1: Short description of the D-AEP.

The GB designed a process control system by creating a dashboard to make the performance (number of admitted patients and the average LOS) transparent and visible. To examine LOS results, we compared the 10 months pre-intervention period (October 2007–July 2008) with the 10 months post-intervention period (August 2008–May 2009). Table 3.2

describes the demographic data of trauma patients who were admitted to the TW in both periods.

	Pre intervention Oct '07- July '08	Post intervention Aug '08- May '09	p-value
No. trauma patients	747	946	
ISS < 16	674	888	
ISS ≥ 16	73	58	0.006
Gender (% male)	65.1%	58.4%	0.005
ISS ≥ 16	84.9%	77.6%	0.364
Age (year)*	45.4 ± 19.9 (42)	46.8 ± 20.0 (45)	0.172
ISS ≥ 16	42 ± 18.2 (41)	41.9 ± 16.3 (41)	0.960
No. of re-admission for follow up treatment	77	74	0.086
Acute admissions	63.7%	63.3%	0.879
Mortality	5 (0.7%)	0	0.017
Discharge to			
Home	78.5%	81.5%	0.141
Rehabilitation facility	16.6%	14.8%	0.313
Another hospital	3.7%	3.1%	0.585
Other	0.5%	0.6%	1.000

*Mean ± Standard Deviation (median)

Table 3.2: Demographic data of the trauma patients admitted pre/post intervention.

The pre/post intervention groups are significantly different regarding injury severity score (ISS): 9.8% complex patients (ISS ≥16) before and 6.1% after the intervention. Patients with high ISS values have generally higher LOS (Andersen et al., 1992; Brasel et al., 2002). Except for the smaller percentage of females and the lower mortality rate in the post-intervention group, there are no other significant differences in demographic variables.

3.3 Results

The performance (2006 and 2007) of the utilization of the TW was analyzed at the Define phase (Table 3.3).

	Admissions			Patient-days			Average LOS			Bed Capacity - Occupation	
	Trauma	Surgery	Other	Trauma	Surgery	Other	Trauma	Surgery	Other	Days	(%)
2006	956	131	27	9,874	588	37	10.3	4.5	1.4		
Total		1,114			10,499			9.4		10,950	95.9%
2007	949	118	57	9,850	567	108	10.4	4.8	1.9		
Total		1,124			10,525			9.4		10,950	96.1%

Table 3.3: Total admissions, patient-days, average LOS, bed capacity and occupation of the TW.

On average, there was always one available bed, but too often trauma patients could not be admitted to the TW. They were then admitted to one of the other surgical nursing wards, and some emergency patients even had to be sent to other hospitals. The two measurements of (in)appropriate hospital stay gave almost identical results: 30% of the hospital stay of trauma patients appeared to be inappropriate. The main influence factors of inappropriate hospital stay can be clustered into five groups. One group represents the patients waiting for a rehabilitation facility or nursing home (49% of the unnecessary LOS). The other groups include delays in discharge planning (18%), patients waiting for surgery (23%), patients waiting for a diagnostic result (4%), and other factors (6%). The high percentage of "patients waiting for surgery" could be explained by their admission one day before the operation to be absolutely sure that a bed is available. The improvements (from August 2008) focused on the discharge planning and elimination of all waiting time of the care process because the trauma personnel themselves could influence these variables.

The most crucial improvement measure was the collective attention of doctors, nurses, and patients to the discharge. When a planned patient is admitted, the expected day of discharge and the expected need for care after discharge is given. Now, a rehabilitation facility, nursing home, or homecare can be organized in a timely manner. For emergency patients, the same information must be available within 24 hours after admission. The doctors have to communicate this information with the patient and write it down on the patient file. Planning is a structural part of the daily deliberations between trauma surgeons and assistant physicians. The average LOS of all patients (surgical and trauma) at the TW is 2.9 days shorter than before the intervention. The average LOS of trauma patients decreased from 11.8 to 8.5. The control chart of Figure 3.2 shows the average LOS of the trauma patients from October 2007 onward.

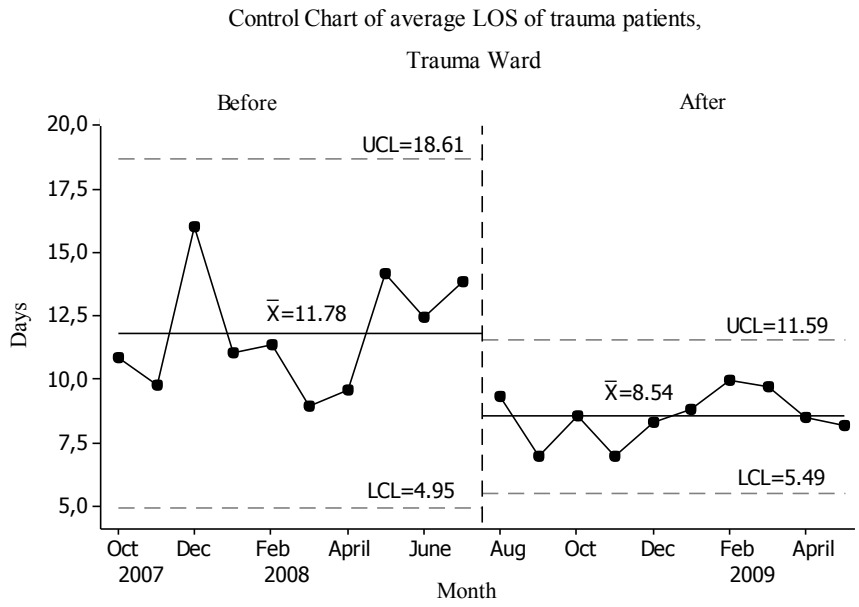


Figure 3.2: Reduction of the average LOS of trauma patients after implementation (August 2008).

The aim of the project was to reduce the inappropriate hospital stay with 50%. Figure 3.3 shows the inappropriate hospital stay in four different weeks.

The reduction of LOS enabled the hospital to admit more and almost all trauma patients to the TW. Most days (80%), the TW has at least two beds available for emergency patients, which is the way it should be in a level I trauma center. In the period September to November 2008, the average number of beds available for the admission of acute patients was 4.4. In 2007, we admitted 1,124 patients (949 trauma, 118 surgical, 57 others), whereas in 2008 this amount increased by 118 extra patients (10% more) (1,034 trauma, 144 surgical, 64 others). Compared with the same period in 2007 (January to August), in 2008, there were 33 fewer admissions, so the increase of admissions was achieved after the implementation. Before the project, the other surgical nursing wards admitted on average 12 trauma patients per month, with an average LOS of 3.6 days. Now only 2.8 trauma patients per month are being admitted to other nursing wards (76% less), with an average LOS of 2.1 days. Based on the diagnosis of the problem, the project team decided to aim at reducing the inappropriate hospital stay with 50%.

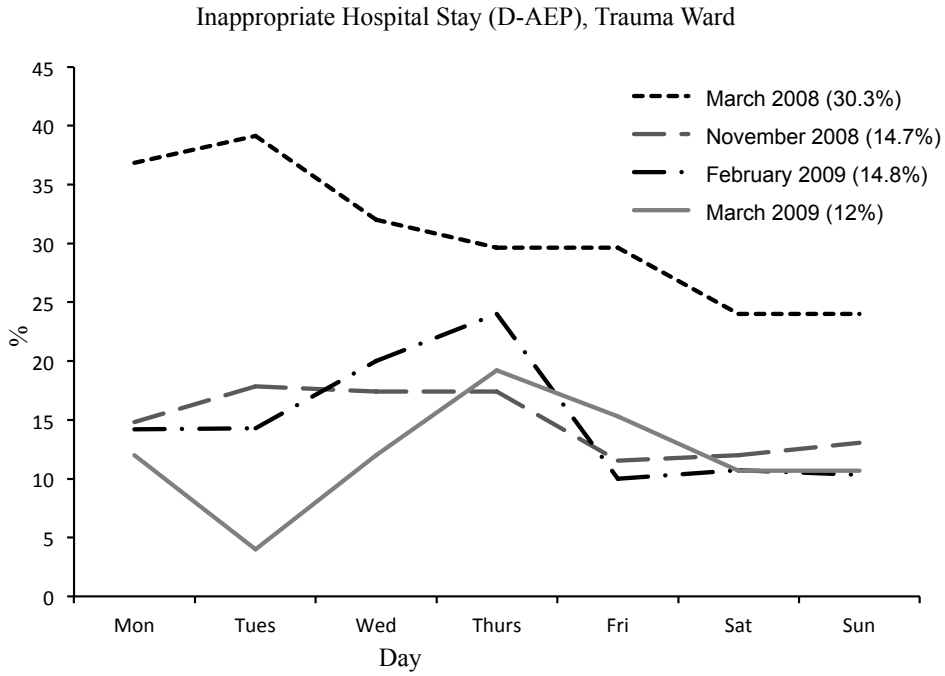


Figure 3.3: Measurements of inappropriate hospital stay in four different weeks.

The average LOS at the TW would then be reduced to 8.2 days, gaining some 1,500 patient-days a year and four beds a day for other use. Previously, we showed that this target was more or less obtained, but the increasing LOS at the beginning of 2009 (Figure 3.2) worried us.

We therefore decided to measure inappropriate hospital stay again. Because these 1-week measurements showed no increase in the inappropriate hospital stay (Figure 3.3), we concluded that the higher LOS could be attributed to more complex patients. This approach using LOS to monitor the process and performing additional measurements of inappropriate hospital stay forms part of the statistical process control system, which is used to detect and respond to irregularities in the process. (De Mast et al., 2012). Measuring inappropriate hospital stay takes 5 to 10 minutes a day. The visual management of these parameters motivates the nurses, doctors, and management to continue to work according to these new standards.

3.4 Discussion and conclusion

The most important influence factor of inappropriate hospital stay was the delay in discharge to a nursing home or a rehabilitation facility. The availability of other care facilities is an external factor of inappropriate hospital stay and can therefore not be controlled by the hospital. But, we can reduce the waiting time for such facilities by making a timely request. Our policy used to be to arrange a bed in a nursing home only after the operation. Now, we arrange a bed immediately after a patient's admission, and so we reduce the average LOS of patients with a hip fracture by more than 4 days. The average LOS of the post-intervention population decreased with 3.2 days compared with the (10 months) pre-intervention population. This LSS project has shown that it is possible to improve quality and reduce costs at the same time.

Another result is the financial benefit for the hospital, based on 118 additional admissions, representing a value of €176,400. In 2007, the nursing wards' costs were almost the same as in 2008, as were the staffing costs. The total patient specific costs (medical and nursing supplies, blood, and other patient-specific costs) increased by only €1,740. So, with a minimum of extra costs the UMCG realized 118 extra admissions to the TW. In 2006, the D-AEP measurement showed that 30% of the hospitals stay at the TW was inappropriate. Two years later, in March 2008, it was still 30%. In fact 30% of inappropriate hospital stay seems to be a common figure; measurements in other hospitals show similar results (Panis et al., 2002; Dizdar, 2007). The positive effects of reducing the inappropriate hospital stay to the current level of 12% enabled us to integrate the new methods into the culture and organization of the TW.

There are several notable limitations to this study. The study was conducted in the specific context of a Dutch university medical center. Contextual factors such as the Dutch healthcare system may have influenced the results. This limits the external validity of the study. Øvretveit (2004) argues the need for attention to intervention conditionality in quality improvement practice. The significant higher percentage (pre-intervention) of patients with an ISS ≥16 may have influenced the LOS and percentage of inappropriate hospital stay, because usually in June and July there are relatively more patients with an ISS ≥16. The number of patients admitted to a nursing home or rehabilitation facility is not significantly different in both periods, however. The delay in these admissions was the most important influence factor of inappropriate hospital stay. We measured process indicators regarding patient logistics, e.g., the average LOS, inappropriate hospital stay, bed occupation, the number of beds

available and the number of admissions. We did not monitor patient satisfaction and patient outcomes. However, we expect that an increase in admissions and in beds available will have a substantial and positive influence on patient outcomes. We do know that the number of readmissions did not increase and that the mortality rate decreased. We do not know, however, whether effects exist on the long-term clinical and functional outcomes such as quality of life.

This study shows that LSS provides an effective method to reduce LOS and inappropriate hospital stay of trauma patients, thereby improving process quality and reducing costs. The introduction of the organizational and conceptual framework of LSS, with specific roles for key players and a program aimed at reducing inappropriate stay appears to be an effective intervention. Within the UMCG, several other nursing wards have taken up the challenge to reduce LOS in a similar way.

Chapter

4

REDUCING OVERUSE OF DIAGNOSTIC TESTS FOR TRAUMA PATIENTS

The wide variety and availability of diagnostic tests is one of the reasons for continually increasing health care costs. Unnecessary clinical risks, physical discomfort and anxiety for the patient are additional effects of overuse or inappropriate use of diagnostic tests. This chapter based on Niemeijer, Trip et al. (2012) describes that Lean Six Sigma enables physicians to avoid redundant diagnostic tests and increase cost awareness.

4.1 Introduction

The pace of medical technological innovation (e.g. new diagnostic tests and medical treatments) brings benefits such as longevity, improved quality of life, and less absence from work (Cutler and McClellan, 2001). A major side effect, however, is rising health care costs (Newhouse, 1992). Crucial is how physicians make use of all the available technological possibilities. Some professionals prescribe barely useful tests and treatments that are potentially harmful for patients, causing unnecessary costs at the same time (Chassin and Galvin, 1998). For patients tests can be painful or stressful, and harm can be done as well by false-positive results (Brandspigel and City, 1994; Owens, 1998; Johnson and Mortimer, 2002). Defensive use of diagnostic tests has been argued to reduce the overall quality of patient care (DeKay and Asch, 1998). An additional reason for higher costs is the fact that providers have an almost complete lack of understanding of the costs of patient care delivery (Kaplan and Porter, 2011).

With the "fitness for use" definition of quality, we understand that more is not necessarily better (cf. Chapter 1). "Fitness for use" implies that the paramount focus should be the patient's needs and expectations (Reeves and Bednar, 1994) and may offer clinicians a conceptual framework for thinking through how to provide better quality while reducing costs. Health care professionals should focus attention on what is "fit" for the particular patient and should prevent overuse, underuse, or misuse of diagnostic tests (Does et al., 2010) to improve resource utilization, to reduce delays and to eliminate processes that do not have added value (Kaplan and Porter, 2011).

Since 2005 the funding of the Dutch healthcare is based on the DTC (Diagnosis Treatment Combination) system with fixed reimbursement per case for providers and medical specialists. For hospitals with budget problems, the waste related to diagnostic tests is an opportunity to decrease costs. At least, this is what the Trauma Unit of the University Medical Center Groningen (UMCG) experienced. The Unit is responsible for emergency, inpatient, one-day surgery, and outpatient treatments after traumatic injury. Critically ill trauma patients are admitted on a distinct ICU service, led by an intensivist. The Trauma Unit serves approximately 10,000 outpatients and 2,000 inpatients / one-day surgery each year. In 2006 and 2007 the diagnostic costs at the clinic were 45 percent of the total patient's specific costs (€853,969). The challenge is to reduce these costs, while maintaining — or even improving — the quality of care.

A project in 2008 aimed at two goals: avoid redundant diagnostic tests and increase cost awareness among medical doctors. The number of diagnostic tests per patient and the cost per diagnostic test were introduced as additional performance indicators. An important side effect is that quality of care improved as well, because patients experience less stress and less exposure to potential adverse effects from the tests itself.

4.2 Methods

Over the last decade, the method of "Lean Six Sigma" (LSS) was introduced in health care to improve efficiency and to provide better care. The healthcare industry is beginning to recognize the value of Lean methods to achieve process optimization (Smith et al., 2011). Also Six Sigma with a combination of industrial safety and reliability and quality management tools represents an effective approach to quality improvement in e.g. surgery (Sedlack, 2010). The key role for improvement in medical care belongs to medical doctors, who directly influence the quality of care and the variable costs.

In February 2008, the head of the Trauma Unit initiated a project aiming at an optimal and appropriate use of diagnostic tests with an expected cost reduction of 10%. The project leader was a physician assistant, who was trained as an LSS improvement specialist (a so-called "Black Belt"). Physician leadership has proven to be an essential condition for a quality improvement project on changing physicians' practice by reducing unnecessary variation in care (Forthman et al., 2002; Xirasagar et al., 2006). The project followed the LSS framework of the Define-Measure-Analyze-Improve-Control (DMAIC) road map (De Mast et al., 2012).

An essential part of the DMAIC road map is to define suitable measurements for the problem, derived from the voice of the customer (VOC) and the voice of the business (VOB), thus indicating what is critical to quality (CTQ). The CTQ-flowdown makes explicit the rationale underlying the project by showing hierarchically how CTQs relate to higher-level concepts, such as an organization's performance indicators and strategic focal points (cf. Chapter 2). The VOC was established as: patients receive optimal care based on as few as possible informative diagnostics tests. The VOB was established as: diagnostic tests are used efficiently, to improve the quality of care. The CTQ-flowdown resulted in a measurement plan to determine the current performance of (redundant) volume and (extra) costs of diagnostic tests.

During the Measure phase, we collected the volumes of all diagnostic tests and patients from January 2007 through July 2008. All diagnostic tests were categorized into three different main groups: laboratory tests (blood and microbiological tests), radiology (inclusive CT, MRI and ultrasound examination), and isotope scans.

The Black Belt analyzed the data, to select the "vital few" diagnostic tests, based on volume and costs, according to the Pareto principle (De Mast et al., 2012). In addition, a "value stream map" with focus on diagnostic tests was made of some treatments. A value stream map is a flowchart with information about workflow, waste (redundancies and inefficiencies) and process performance of diagnostic testing (e.g., number, frequency, prescription order), from a customer's point of view. The analysis identified root causes for possible overuse or misuse of diagnostic tests:

- Lack of standards for laboratory tests.
- Insufficient experience of the resident physician.
- Lack of supervision of the resident physician at the daily bedside round.
- Early postoperative diagnostic imaging.
- Lack of knowledge and ownership regarding volume and costs of diagnostics.

These causes affect the CTQ behavior and are the cause of problematic or substandard performance.

A few years earlier (before 2007), the clinic standardized the guidelines for diagnostic imaging for common and uncomplicated injuries, to secure the quality of care by the resident physicians at the emergency room and clinic. For example, the guidelines required a one-day postoperative radiograph for the clinical treatment to verify the treatment result. Often,

however, the quality of this measurement was insufficient because of the poor physical condition of the patient. Another radiograph was needed for proper verification. The guidelines were especially directed toward conventional radiology; CT, MRI, and PET scans were not part of the guidelines and ordered as deemed needed by the physicians. For the laboratory diagnostics (contributing to 75% of the total number of diagnostic tests), no guidelines existed at all. The resident physician requested laboratory diagnostics at will, often without considering clinical consequences.

At the end of the Analyze phase the results were presented to the medical staff. We learned that the majority lacked the knowledge of volume and costs of diagnostic tests. Most physicians were surprised to learn that a CT scan was 5.7 times as expensive as a conventional radiograph, and a PET scan was 29.6 times as expensive as a bone scintigraphy.

The root causes of waste and inefficiencies were the basis for improvement actions of the Improve phase of the DMAIC road map. Designing improvement actions was a team effort of the trauma surgeons. Two types of actions can roughly be distinguished: the creation of a “lean mindset” and evidence-based medicine.

Creating a lean mindset is a continuous process. The main characteristics are standardization of work processes and reduction of waste. Five improvements show this in more detail.

1. Postpone the postoperative radiograph to check the reposition and fixation of the fracture(s) by 1 or 2 days, to avoid unnecessary repetition.

2. Daily diagnostics were not ordered, unless a superior approves. As all patients are different, directives for daily laboratory diagnostics were prohibited.

3. Diagnostic tests are only ordered when the official information will be useful for patient care. If the treatment will be the same, irrespective of the outcome of the test, then the test does not serve the patient. At the patient deliberation, this is now a daily explicit consideration.

4. The medical need for diagnostics is now on the agenda of the daily patient’s review, a meeting of trauma surgeons and resident physicians, to improve communication between surgeons and resident physicians. The resident physician presents all new patients and patients for surgery in the past and next twenty-four hours. If necessary

the review results in a second bedside round of the day to examine the patient together with the supervisor.

5. The resident physician in the clinic and outpatient clinic may contact a supervisor (a staff member) to discuss treatment and diagnostics. At the end of the day, the supervisor takes time to meet the resident physician in the clinic, to coach about treatment in nonstandard situations, and to prevent overuse of diagnostic tests. Supervision by senior staff and leadership are of paramount importance for rationalizing laboratory utilization (Miyakis, 2006).

Evidence-based medicine leads to a number of improvements, of which the two most important ones are mentioned here. The DEXA scan and PET scan scored high in the top 10 of diagnostic costs. The DEXA scan of the distal radius was part of the screening protocol for osteoporosis, even though it is not evidence-based anymore (Dutch Institute for Healthcare Improvement CBO, 2002). We therefore skipped the test and adjusted the protocol jointly with the, other involved, departments of internal medicine and radiology. We also investigated the performed PET scans and learned that only one of six scans had added value. These expensive scans are now only requested after permission of the clinic head.

We emphasized the principle that additional diagnostics should be considered only based on the patient's medical history and physical examination. Following the literature (Blery et al., 1986; Brandspigel and City, 1994; Johnson and Mortimer, 2002), the same principle was applied for preoperative tests. The actions were implemented at the nursing department and outpatient clinic. For acute (poly)trauma patients, there are specific guidelines for the use of diagnostic radiology tests and treatments for almost every type of injury.

The Control phase of the DMAIC road map serves the purpose of maintaining the improvements. New protocols are to become new standards adhered to by everyone. An essential element of quality improvement is that employees experience a sense of control (De Mast et al., 2012), that is, ownership to influence the process and its outcomes. For this project, it meant the following:

- Agreement between the staff and resident physicians about responsibilities and expectations regarding ordering diagnostics.

- The duty for everyone to account for requested diagnostics, with clinical consequence in mind.
- Visual management (e.g. control charts) with regular feedback on volume and costs of diagnostics.
- Active supervision of the staff on diagnostic requests from resident physicians.

This phase is also the start of continuous improvement. With visual management and involvement of everybody, this is now actively practiced. The results of the project were concluded from a comparison of monthly data of diagnostic tests, from nineteen months before and thirty-three months after the intervention with improvement measures in July 2008. Either the two-sample t-test or the two-sample Poisson rate test was used to judge a significant difference between the two periods (before and after).

4.3 Results

The average number of tests per treatment decreased significantly by 16% (see Table 4.1). This is a combined result of 7% less diagnostic tests and 10% more treatments in the period after the intervention. The largest relative decrease was in the category of laboratory tests, where no guidelines existed. This clearly stresses the need for standardization.

Table 4.1 shows that the volumes of tests decreased in all groups except radiology. The 18% reduction after the intervention in the clinical setting is especially interesting. This reduction was obtained by fewer laboratory tests at the clinic and one-day surgery patients. The data show an average reduction of the most commonly used tests per treatment: Hemoglobin (-78%), platelets (-57%), white cell counts (-31%), chloride (-23%), potassium (-17%), calcium (-28%), sodium (-17%), urea (-12%) and creatinine (-12%). Some of these tests were ordered in a standard manner for preoperative laboratory testing.

A control chart (a trend chart with warning limits (De Mast et al., 2012) is shown in Figure 4.1. The chart suggests a decrease in diagnostic tests in March 2008, immediately after the start of the project in February. A Hawthorne effect—improvements based on attention only—may be responsible.

	Patients/ setting	Pre (average per month)	Post (average per month)	Difference %	p-value
Treatments	All	1008.68	1110.27	10	0.001
	Inpatient and one-day surgery	161	192.33	19	
	ISS >16	19.26	17.03	- 12	0.139
Laboratorial tests	All	5458.58	4830.42	- 12	0.004
	Inpatient and one-day surgery	2688.11	2158.94	- 20	0.003
Radiology	All	1776.42	1895.06	7	0.012
	Inpatient and one-day surgery	267.68	257	- 4	0.309
Isotope tests	All	94.68	69.06	- 27	0.000
	Inpatient and one-day surgery	2.16	0.76	- 65	0.000 ‡
Pathology tests	All	8.74	6.85	- 22	0.074
	Inpatient and one-day surgery	1.63	2.30	41	0.089 ‡
PET-scans	All	0.32	0.06	- 81	0.060 ‡
Total of diagnostic tests	All	7338.74	6801.45	- 7	0.016
	Inpatient and one-day surgery	2959.84	2419.67	- 18	0.003
Average number of diagnostic tests per treatment	All	7.35	6.14	- 16	0.000
	Inpatient and one-day surgery	18.68	12.68	- 32	0.000

‡ 2- Sample Poisson Rate Test

Table 4.1: Average number of treatments and diagnostic tests before (19 months) and after (33 months) intervention.

However, lasting improvements do require a formal intervention with new protocols and guidelines. In July 2008, the improvements were formally implemented.

In Figure 4.1, we see a clear (and lasting) drop and less variation in the average number of tests per treatment after the intervention. Diagnostic tests per treatment of inpatient and one-day surgery patients (Figure 4.2) decreased also substantially after the intervention.

We also introduced control charts to monitor current performance, because the charts are valuable to physicians and managers in controlling variation (Berwick, 1991; Blumenthal, 1993; and Forthman et al., 2002). A monthly update of the data enables management of the clinic to measure and analyze the diagnostic request process at a glance (visual management).

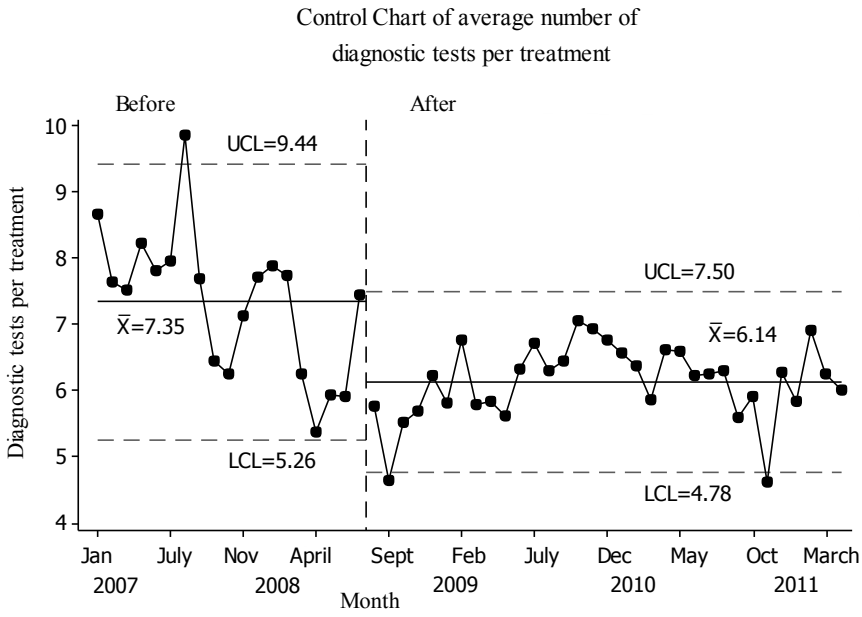


Figure 4.1: Average number of diagnostic tests per treatment before and after intervention.

As a result of the interventions the average cost of diagnostics per treatment decreased from €32.44 to €28.51. Additional benefits for the Traumatology clinic were obtained by reducing and standardizing diagnostics at osteoporosis screening, saving 0.5 fulltime equivalent (€27,000) from a specialized nurse.

4.4 Discussion and conclusion

This study proves that the LSS method is successful in health care to improve care processes, eliminate waste, reduce costs and limit patients' exposure to effects of overuse or inappropriate use of diagnostic tests. The systematic approach of Six Sigma (the DMAIC road map), combined with easily applicable tools from Lean thinking, allows quick results. These results can be made permanent when physicians accept ownership of the improvements and utilize management information, preferably in the form of a dashboard or a similar type of visual aid.

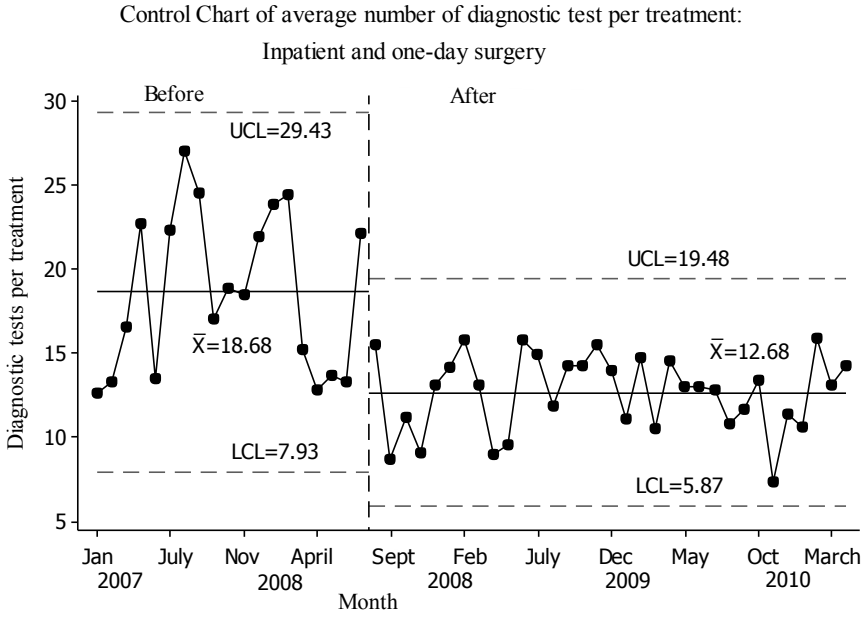


Figure 4.2: Control chart of diagnostic tests per treatment of inpatients and one-day surgery patients before and after intervention.

The scope of a project requires serious consideration. In this project, for example, the critical ill patients at the ICU were excluded because the Trauma Unit had no formal authority to influence the procedures of intensivists.

The project at the Trauma Unit was part of the introduction of LSS in the UMCG, which started already in 2007. The reason was an increasing focus on costs and quality of care in the whole organization. This might explain the decreasing number of diagnostic tests (for inpatient and one-day surgery patients) immediately after the start of the Traumatology project in February 2008. Generally, a Hawthorne effect is only temporary, and the "old" situation will return. The aim of LSS is, however, to find and implement lasting improvements. Active supervision of the trauma surgeons regarding diagnostic requests from, a limited number of, resident physicians at the trauma ward is an important success factor. At the emergency room, with a wider supervisory span of control for the same trauma surgeons, improvements were observed only after formal interventions.

A smaller number of polytrauma patients (injury severity score ≥16 by emergency treatment) after the intervention might also be a reason for less diagnostic tests. But the 12% decrease from 19.3 to 17 is not significant (and less than the 16% overall decrease in tests per treatment). The observed increase in radiology diagnostics might be attributed to a combination of an increasing number of patients and pre-existing partial standardization of diagnostic imaging.

The results of the project are lasting. In 2010 the overall cost was 1.2% lower than in 2007, despite 10% more treatments. Selective and timely approach of diagnostic tests resulted in average cost savings of 12.1% or €3.93 per patient. For the clinic, this represents €52,360 annual cost savings.

A limitation of the study is that nothing pertinent can be said about patient outcomes and patient satisfaction. This research was not specifically designed to evaluate factors related to clinical outcome. The study design and the size and diversity of the study population of 55,804 treatments make it difficult to determine a specific relation between outcome (e.g. morbidity) and selective ordering of diagnostic tests. We may expect a positive effect on patient outcome, however, because treatment guidelines have not been changed, and the selection of diagnostic tests is better aligned to what is “fit” for the patient. Continued daily use of diagnostic laboratory tests (e.g. hemoglobin, C-reactive protein) has no added value when the results conform to the reference laboratory values. There is now a collective awareness that the need of clinical consequence is the norm for additional diagnostics. Trauma surgeons, for instance, deliberate about the need for preoperative CT scans in cases of possible preexisting sufficient imaging of the fracture.

Development of (new) protocols was beyond the scope of this study. During the four years of the study, there have been no major changes in diagnostic tests and treatment protocols of the different injuries or in the number of outpatient visits. Neither did “reference ranges” of the laboratory tests change, nor did we compromise our postoperative tests. Before and after the improvements, laboratory tests were ordered per single test and not in panels. Contextual factors, like the Dutch health care system, may have influenced the results, and the external validity of the study can be improved by replicating this approach to reduce the overuse of diagnostic tests in other contexts. The results of this project stimulated the sense of ownership among physicians in using medical means and shared responsibility to improve processes and reduce costs while improving the quality of care.

Chapter

5

THE DEVELOPMENT OF A CLINICAL PATHWAY FOR HIP FRACTURES

This chapter based on Niemeijer, Flikweert et al. (2012) describes the usefulness of Lean Six Sigma for the development of a multidisciplinary clinical pathway for hip fractures in the elderly, with the aim of improving efficiency of care and reducing the length of stay.

5.1 Introduction

The incidence of osteoporotic hip fracture of the elderly is recognized as one of the global major public health problems and expected to rise from 1.66 million in 1990 to 6.26 million by 2050 (Cooper et al., 1992). Hip fractures are associated with a mortality rate of 5-10% after one month and with 33% at one year (Roche et al., 2005; Parker and Johansen, 2006) and with considerable financial costs for hospitals. More than 80% of the costs are related to ward costs. This emphasizes the growing economic impact arising from the (reduction of) length of stay (LOS) of inpatient treatment of hip fractures (Lawrence et al., 2005). Strategies to improve the efficiency and consequently to reduce costs by improving the utilization of equipment, personnel and facilities are needed.

In theory, physicians should always produce the greatest increment of patient health, using a sequence of services, in a specific timeframe, given a specified available budget (Donabedian et al., 1982). Hospitals use clinical pathways (CPW) to improve the organization of care (Müller et al., 2008; Kinsman et al., 2010; Van Herck et al., 2010). CPW try to achieve optimal clinical results with efficient procedures, which are continuously improved with plan-do-check-act cycles (Vanhaecht et al., 2010). It has been established that CPW are effective methods to reduce LOS significantly (Vanhaecht et al., 2009; Rotter et al., 2010), and to organize a hip fracture program (Pedersen et al., 2008; Kates et al., 2010).

This chapter describes how we developed a clinical pathway for elderly patients with a hip fracture, based on the definition that CPW are structured multidisciplinary care plans used by health services to detail steps in the care of patients with a specific clinical problem (Lawrence et al., 2005). We used the method of Lean Six Sigma (LSS), a combination of Lean Production (De Souza, 2009) and Six Sigma (Kumar and Thomas, 2010). These

methods are developed in industry to improve quality, reliability, flexibility, delivery and efficiency of processes. More recently, in healthcare these methods have been used to improve the organization and quality of care (Langabeer et al., 2009; Kenney, 2010), and to reduce costs (De Mast, 2007 and 2012).

5.2 Methods

This single center, prospective, non-randomized controlled study was conducted at the departments of Traumatology and Orthopedic surgery at the University Medical Centre Groningen, the second largest hospital of the Netherlands. The two departments have 62 beds available for acute and elective care and admit approximately 2350 patients a year.

In 2007 the board of the hospital introduced LSS as a method to improve organizational quality and to reduce costs. Several employees were trained to become an LSS project leader, to improve processes as part of their jobs. LSS offers the roadmap of DMAIC (Define, Measure, Analyze, Improve, Control) as an improvement methodology and a conceptual organizational framework with specific roles for project leaders ("black and green belts" in LSS terms) and project owners ("champions") to improve processes.

The DMAIC phases are milestones for the improvement project and integrate quality tools and techniques like failure mode and effect analysis and statistical process control (Schroeder et al., 2008). Process and outcome measurements are combined with project metrics into a systematic review process, so that management can manage the progress of the projects Barney, 2002).

The medical staffs of traumatology, orthopedics, geriatrics, anesthesia, and a nursing home decided in 2008 to develop a multidisciplinary clinical pathway as a collaborative care program for elderly patients with a hip fracture, to streamline the care process, to improve quality of care and clinical outcomes, and to reduce LOS and costs. The assignment was given to the chief nurse of the orthopedic ward, who – inspired by successes of a LSS project (Chapter 3) – took up the challenge of integrating LSS with developing CPW. In the following we describe the 5 DMAIC phases. We discuss the results in the next section.

Define

The aim of the project was to develop a clinical pathway, using the LSS method. The Define phase of the DMAIC roadmap is concerned with defining the problem to be solved. That we had a problem was obvious from the bed occupation rates (97% and 89% at the

trauma and orthopedic ward resp.) and frequent unavailability of beds to admit new patients. The project charter determined the project leader (chief nurse of the orthopedic ward), process owners (trauma surgeon and medical head of the Trauma department), scope, timeline, and auxiliary members of the project team. To put the problem in perspective, a SIPOC (Supplier, Input, Process, Output, Customer) was made, leading to a detailed flowchart of the process at micro level. The process leader did a stakeholder analysis, to chart the stakes and the influence of the people involved.

Measure

To quantify the current process performance, we needed appropriate measurements, the so-called Critical to Quality (CTQ) indicators in LSS terms. A CTQ flowdown was used to translate the rationale underlying the project into performance indicators and strategic focal points (Chapter 2). The CTQ flowdown resulted in a measurement plan to determine the current performance of LOS, the number of clinical intakes, and throughput time of the (main) process. The strategic focal points were: capability for admittance to the hospital from the perspective of the patient and increasing revenue from the perspective of the hospital.

According to the measurement plan a retrospective data collection (2006-2007) was obtained from the digital information system. This data (including patient characteristics, LOS and throughput times) was validated by a comparison with the paper files of a random sample of twenty patients. In 2006 and 2007, 137 patients with an isolated hip fracture were admitted. Exclusion criteria were multiple injuries, acute cerebral vascular accident and in-hospital mortality (n=7).

A second dataset was obtained prospectively from all admitted patients in the period November 2008 – January 2009. This data was used to make a value stream map (De Mast et al., 2012) of the current process performance with information about workflow (process times) and waste (waiting times and other inefficiencies), see Figure 5.1. The value stream map was determined from the patient's point of view.

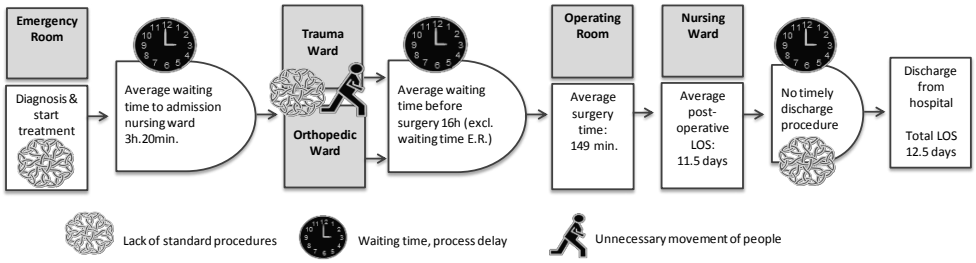


Figure 5.1: Value stream map of process performance November 2008 – January 2009.

A third dataset was obtained prospectively after the implementation of the clinical pathway (July 2009 – December 2010) to establish the effects of the improvement actions on LOS. In this period data from 195 admitted patients were collected.

Analyze

The aim of the Analyze phase is to arrive at a data based diagnosis of the current process performance. The LOS of patients in the retrospective dataset (2006-2007) was analyzed with analysis of variance (ANOVA) techniques for categorical variables and regression analysis for continuous variables (age and duration of surgery) to identify significant influence factors (see Table 5.2).

For the second dataset we used descriptive data analysis to estimate process inefficiencies (cf. Figure 5.1). And we identified potential improvement actions from exploratory data analysis: a few BOB (best of the best) cases were compared with a few WOW (worst of the worst) cases to find recurring patterns. The first observation was that no standard procedures and protocols of multidisciplinary intake existed, with the effect that the waiting time before admission to the nursing ward (NW) could be too long. The second observation was that the preoperative consult of the anesthesiologist took place at the NW and that (additional) diagnostic tests were performed depending on the co-morbidity, resulting in unnecessary movement of patients and personnel at the NW. The third observation was that the discharge procedure often started between one and three days after the surgery, with the effect that the patient was discharged later than necessary.

Improve

After the process was diagnosed, the project team determined objectives for interventions to eliminate waste, and to reduce waiting times, resulting in a reduction of LOS. The main characteristics of the interventions are standardization of work processes and care (Table 5.1).

Current process	Planned interventions
1. Average waiting and treatment times of 200 minutes at the Emergency Room (ER).	1. Standardized multidisciplinary procedure of the diagnostic process at the ER within 120 minutes.
2. Different protocols for intake by multidisciplinary team at ER and nursing wards (NW).	2. Standardized protocols for intake and diagnostic tests by all multidisciplinary teams (traumatology/orthopedics and anesthesia) at the ER.
3. Different treatment protocols at traumatology and orthopedic medical en and nursing departments.	3. Standardized treatment protocols for both medical and NW.
4. No standards for discharge planning.	4. Standardized discharge planning for both NW: - Discharge planning starts within 24 hours after admission, but before surgery. - Determination of a collaborative interdisciplinary rehabilitation program of hospital specialists and the medical doctors at a specific nursing home. Each week the nursing home reserves two or three beds to admit new patients.
5. Average duration of surgery of 149 minutes	5. Average duration of surgery reduced by 60 minutes through: - A daily-labeled schedule to operate patients with a hip before the starting time of earlier planned semi-elective surgeries. - The surgery is performed by or in presence of a senior surgeon.

Table 5.1: Objectives and interventions for optimized care process.

In June 2009 the multidisciplinary teams started working according to the new standards of the clinical pathway.

Control

The new process is actively monitored, to assure that better results are retained. A specialized nurse compiles a prospective database with relevant data of every elderly patient with a hip fracture, to keep track of the care process. This database is used for the frequent multidisciplinary evaluations of the patients, and for examining the impact of the

improvements. We use the prospective data from July 2009 – December 2010 to analyze the LOS before and after the interventions (using ANOVA).

5.3 Results

The retrospective data from 2006 and 2007 are used to set the baseline result. Table 5.2 shows the effects of potential influence factors on LOS. The average LOS of elderly patients with a hip fracture was 13.5 days. Three of the investigated variables have significant influence. The first is the age of the patient: the LOS of female patients is significantly higher than the LOS of male patients. The second variable is duration of surgery, defined as the time from starting the anesthesia to wound closure. Patients with surgery lasting more than two hours have significant higher LOS. Note that the patient with 38 days LOS and duration of surgery of 52 minutes is clearly an outlier. The third variable is the nursing department. Patients who were admitted at traumatology had on average two days longer LOS than patients admitted at orthopedics. For all three variables we scored in the direction of higher LOS: 69% female patients, 75% surgeries lasting at least 2 hours, and 66% admissions at the Traumatology nursing department.

Variable		N	LOS: Average ± SD (Median)	p-value
All Patients		137	13.50 ± 10.17 (11)	
Gender	Male	42	10.33 ± 6.18 (8.5)	0.015 ¶
	Female	95	14.89 ± 11.24 (12)	
Age	< 75	47	11.96 ± 7.64 (11)	
	76-85	47	14.72 ± 11.20 (11)	
	86-95	42	13.79 ± 11.49 (11)	0.316 Ψ
	96-105	1	16	
Department	Traumatology	90	14.26 ± 10.02 (12)	
	Orthopedics	47	12.04 ± 10.39 (9)	0.228 ¶
ASA-classification	1-2	47	12.51 ± 6.36 (11)	
	3-4	90	14.01 ± 11.67 (11)	0.414 ¶
Duration of surgery	< 60 min.	1	38	
	60-90 min.	6	9.33± 5.39 (8)	0.018 Ψ
	91- 120 min.	27	9.70± 5.86 (7)	
	> 121 min.	103	14.50 ± 10.77 (12)	
Discharge destination	Nursing home	93	14.42 ± 10.53 (12)	
	Home	40	11.75 ± 9.53 (10.5)	0.279 ¶
	Others	4	9.50 ± 3.87 (8.50)	

¶ Analysis of variance
Ψ Regression analysis

Table 5.2: Effects of potential influence factors on LOS.

The observations during the project (the second dataset) revealed that the average LOS at the traumatology department decreased to 10.5 days (n=27). The LOS at the orthopedics department was unchanged (n=16). We also observed that the average LOS at the Emergency Room was 192 minutes. Almost all patients were operated within 48 hours, with an average waiting time of 28 hours and 57 minutes.

The third dataset showed that LOS decreased even further after the implementation of the interventions. The overall average LOS reduced from 13.5 days before to 9.3 days after implementation of the clinical pathway (-31%). The difference between departments is not significant anymore (p=0.203). The financial rewards of this LOS reduction amounts to annual cost savings of €120,000. Table 5.3 shows the influence of all variables on LOS.

Variable	N	Before (n=137): Average LOS ± SD (Median)	After (n=195): Average LOS ± SD (Median)	Difference Average LOS %	p-value
All Patients		13.50 ± 10.17 (11)	9.3 ± 9.8 (7)	-31	0.000
Gender	Male	10.33 ± 6.18 (8.5)	8.59 ± 6.5 (7)	-17	0.173
	Female	14.89 ± 11.24 (12)	9.60 ± 11 (7)	-36	0.000
Age	< 75	11.96 ± 7.64 (11)	10.5 ± 14.23 (7.5)	-12	0.520
	76-85	14.72 ± 11.20 (11)	8.70 ± 6.50 (7)	-40	0.000
	86-95	13.79 ± 11.49 (11)	8.52 ± 3.73 (8)	-38	0.004
	96-105	16	5.5 ± 1 (5)	*	*
Department	Traumatology	14.26 ± 10.02 (12)	9.27 ± 6.55 (7)	-35	0.000
	Orthopedics	12.04 ± 10.39 (9)	9.3 ± 14.16 (7)	-23	0.257
ASA-classification	1-2	12.51 ± 6.36 (11)	8.35 ± 5 (7)	-33	0.000
	3-4	14.01 ± 11.67 (11)	10.13 ± 12.67 (8)	-27	0.029
Surgery time	< 60 min.	38	8.42 ± 7.25 (6)	*	*
	60-90 min.	9.33 ± 5.39 (8)	8.2 ± 4.56 (7)	-12	0.568
	90 -120 min.	9.70 ± 5.86 (7)	10.49 ± 15.03 (7)	+ 8	0.794
	>121 min.	14.50 ± 10.77 (12)	9.47 ± 4.18 (8.5)	-35	0.006
Discharge destination	Nursing home	14.42 ± 10.53 (12)	10 ± 10.99 (8)	-31	0.002
	Home	11.75 ± 9.53 (10.5)	6.95 ± 2,69 (7)	-41	0.002
	Others	9.50 ± 3.87 (8.50)	6 ± 1.41 (6)	*	*

Table 5.3: Difference in LOS related to (influence) variables.

The average LOS decreased irrespective to discharge destination: nursing home -31% (-4.4 days), home -41% (-4.8 days) and others -37% (-3.5 days). The duration of surgery has

no longer significant influence on average LOS (p= 0.203). The final table in this section shows a comparison of demographic factors between the control group of the first dataset and the group of patients after the project (the third dataset).

The duration of surgery decreased significantly. After the interventions, 80% of the surgeries had duration of less than two hours. There were significantly more patients with ASA-classification 1-2 after the interventions. However, there was no difference (p= 0.236) in average LOS between the categories ASA1-2 (8.4 days) and ASA 3-4 (10.1 days).

Variable		Before project (n=137)	After (n=195)	p-value
Gender (%)	Male	42 (30.7)	63 (32.3)	0.750 ¶
	Female	95 (69.3)	132 (67.7)	
Age years, mean (SD)	All	79.43 (9.77)	78.3 (9.38)	0.288 **§**
Age years (%)	< 75	47 (34)	74 (38)	
	76-85	47 (34)	69 (35)	
	86-95	42 (31)	48 (25)	0.491 ¶
	96-105	1 (1)	4 (2)	
Department	Traumatology	90 (66)	129 (66)	0.931 ¶
	Orthopedics	47 (34)	66 (34)	
ASA-classification (%)	1-2	47 (34)	94 (48)	
	3-4	90 (66)	101 (52)	0.011 ¶
Duration of surgery, mean (SD)		154 (47.72)	98 (34.16)	0.000 §
(%)	< 60 min.	1 (1)	24 (12)	
	60-90 min.	6 (4)	65 (33)	0.000 ¶
	91- 120 min.	27 (20)	68 (35)	
	> 121 min.	103 (75)	38 (20)	
Discharge destination	Nursing home	93 (68)	149 (76)	
(%)	Home	40 (29)	44 (23)	0.152 ¶
	Others	4 (3)	2 (1)	

§ ANOVA
¶ $\chi 2$ test

Table 5.4: Comparative demographics before and after implementation CPW.

5.4 Discussion and conclusion

The aim of the project was to develop a clinical pathway, using the LSS method to identify the most important variables influencing LOS. The additional value of LSS is the combination of the use of a structured DMAIC roadmap, the conceptual organizational framework with specific roles during the project and the integrated use of quality tools and techniques. The systematic approach keeps you concentrated at the strategic focus points and the CTQ's. The project charter creates ownership by medical doctors, a necessity for

implementation of improvement actions. The analysis of the process, using statistical methods on valid and reliable data, gives an objective diagnosis of the current state. The most important influence variables are detected, and selected for improvement actions. Finally, the tools and structure to monitor the process are useful instruments for continual process improvement. The results of this study confirm the idea that LSS is a valuable method for redesigning the care process and for creating a clinical pathway.

The retrospective analysis of the first dataset indicated a few variables leading to a prolonged LOS, being a female patient is one of them. This result differs from Deakin et al. (2008), who reported a significant higher risk for male patients of requiring discharge to a nursing home. Cultural aspects of a society might well be the reason for this difference. The duration of surgery was also important for LOS variation. Collins et al. (1999) concluded that intra-operative factors generating the highest risk for a prolonged LOS; therefore efforts should be made to improve the intra-operative process of care. As a result of the interventions at the intra-operative process, duration of the surgery has no longer a significant effect on the average LOS.

The retrospective analysis of the first dataset also revealed a difference in LOS between the (nursing) departments. The second dataset showed that the average LOS of the elderly with a hip fracture at the traumatology department reduced with an impressive 27%. Another LSS project, to reduce inappropriate hospital stay for all trauma patients (Chapter 3), was responsible for this result. The findings of that project were reestablished in the BOB versus WOW analysis of this new project, and helped achieving more LOS reduction through further improvements of procedures for rehabilitation at and discharging to a nursing home. The average LOS of these patients reduced to 10 days.

Not every quality aspect of CPW is investigated in this study, however. We used a historical control group, and it was not possible to include outcome measurements, such as complications and quality of life, as there was no structured registration of complications in 2006 and 2007. Other studies (e.g. Mc Aleese and Odling-Smee, 1994; Collins et al., 1999; Foss et al., 2007) have shown the impact of separate and interactive factors such as complications to a prolonged LOS. Longer LOS is associated with an increasing risk of hospital-induced complications e.g. enquired infections (Schimmel, 2003).

Further research is needed to investigate the effect of LSS on quality of life patient's satisfaction and patient's outcomes. In spite of the limitations, we have demonstrated the value of LSS to improve the process of delivering care. Tables 5.3 and 5.4 show the significant ($p= 0.000$) reduction of the average LOS and duration of surgery, respectively. We

therefore conclude that the interventions were successful. The improved discharge procedure contributes substantially to delivering the right care at the right place.

The improvements do not lead to a reduction of the average length of stay at the Emergency Room. The most important reason for the actual process delay is the fact that ER doctors treat patients with a hip fracture just like other patients in the ER. There is no preferred treatment and the average length of stay for all patients on the ER is more than 3 hours. The goal set by the board of the hospital is to treat patients in the ER within four hours and with respect to that time path 200 minutes is sufficient. Nevertheless the multidisciplinary standardized intake at the ER created a reduction of unnecessary movements of patients and personnel at the NW. Furthermore, care for patients are ameliorated since they are transferred on a hospital bed with anti-decubitus mattress on the ER already instead of lying on a stretcher.

Several limitations of this pilot study need to be acknowledged. The sample size is relative small and contextual factors, like the Dutch health care system, may have influenced the results. The external validity of the study can be improved by replicating the approach to create CPW for different groups of patients or in other contexts. In summary, the findings of this study suggest that LSS can be useful for the development of a CPW to identify (influence) variables of process of care and to manage the organization of care quantitatively.

Chapter

6

IMPACT OF FIVE YEARS LEAN SIX SIGMA IN A UNIVERSITY MEDICAL CENTER

In 2002 the Red Cross Hospital in Beverwijk was the first Dutch hospital to use the Six Sigma method (Van den Heuvel et al., 2005). The achieved results were enthusiastically published and promoted. Other hospitals were attracted, including the University Medical Center Groningen (UMCG). In 2007 the UMCG introduced the Lean Six Sigma methodology, aiming at cost reduction and quality improvement, and creating the financial possibility to develop innovations. The Traumatology department joined this program in 2008. A physician assistant was trained to be a green belt, with a project aiming at reduced loss of stay. The results of the project were promising, and the department decided to use the LSS approach for new improvement projects. In preceding chapters some of the projects were already described.

This concluding chapter based on Niemeijer, Trip et al. (2012) describes how LSS was introduced in the UMCG, and how it developed in the following years (section 6.1). Section 6.2 focus again at the Traumatology department, where the main processes have been analyzed and improved during the years 2008-2011. Both the approach and the results are briefly described. In the final section (section 6.5) we give our overall conclusion.

6.1 Introduction of Lean Six Sigma at the UMCG

A major intervention in an organization, such as introducing Lean Six Sigma (LSS), requires top management commitment. The introduction therefore started in 2007 with a half-day “champion training” for senior management, about basic knowledge of LSS and the specific role of managers/champions in the program. An external consultant was hired for training sessions to management and employees, and an external master black belt for support of the projects. Selected high potential employees from all over the organization were trained to become an LSS project leader: a fourteen days training for black belts (fulltime project leaders) and an eight days training for green belts (part-timers). These trainings explain the DMAIC roadmap, with the corresponding tools, and the students are

required to practice the new knowledge in a project. Projects were selected from all over the organization, ranging from length of stay and nursing efficiency, to energy saving, computer maintenance, and registration. Many projects aimed at solving really hard problems, such as improving efficiency of the operation theatre, or collective purchasing of implants.

The first experiences with the program were promising. Belts started enthusiastically, describing processes and determining relevant measurements: "Critical to Quality" parameters, or CTQ's. Both elements were relative new to large parts of the organization. Process descriptions of patient treatments (critical pathways) existed, of course, but most management processes were just simply there. Many data were registered, but seldom according to generally accepted standards. As a consequence there used to be much confusion regarding measurements. Many key players collect their own data and their own version of reality, which is a major drawback for change. The value of an LSS project is that the context of a problem is clearly delineated and that valid, accurate and precise measurements are collected to quantify the problem. The medical doctors in the UMCG appreciated this kind of diagnosis to managerial problems.

Most of the projects proceeded according to plan in the analysis and improvement phases. Improvement actions were designed and the calculated results were realized. But the progress of several projects ended when the actual interventions were to be done. Later on a few reasons were identified:

- Interventions were beyond the scope of the champion.
- Internal budgets and oblique financial structure made interventions financially unattractive.
- Implementation depended heavily on external capacity (especially ICT capacity).

These reasons can be related to the specific organization of the UMCG: decentralized, divided into ten sectors and managed by sector managing directors. Medical departments are part of a sector, but with their own budgets and direct relations to the management board. The financial system is very complicated, with more than 1,000 sources of income (the ministries of Health and Education, the European Union, and insurance companies

being the most important ones). Internal finance is likewise complicated and not transparent. It is difficult to calculate cost prices of activities. When the LSS program started it was thought that the champion of a project was authorized to intervene in the whole organization. After all, the improvement actions were well grounded, based on scientific methods. But it turned out that this was a step too far: most managers did not allow interference at their departments from plans designed by others. The lesson was that for projects to be successful the scope should be limited to the organizational scope of the champion. And for large problems, with more than one manager (or decision maker) involved, concerted efforts had to be organized.

Notwithstanding some negative experiences with implementing improvements, management decided to continue using LSS as the method for efficiency and quality improvement. Many projects were successful in demonstrating that processes comprised wasteful activities. It became clear to management that these activities could be skipped without compromising quality of care, and at the same time saving money for the organization. LSS could indeed be used as a vehicle for judicious cost saving: see Wijma et al. (2009) for a project about nursing efficiency.

6.2 Development of Lean Six Sigma at the UMCG

During the first two years the in-house LSS trainings were given twice a year by the external consultant. He trained 82 employees: 19 black belts and 63 green belts. As mentioned before Black belts are fulltime LSS project leaders, usually staff members and green belts are temporarily assigned to LSS projects, usually two days per week, next to their normal work as manager, nurse or medical doctor. Up until 2011 there have been 163 official projects (Table 6.1), in nearly all parts of the organization, but with an emphasis on the primary process of patient treatment and care. The nursing efficiency and length of stay of every nursing department has been analyzed. The categorization of table 6.1 is based on nine generic project definitions (Niemeijer et al., 2011).

Primary process of patient care	Frequency	Management and hospital organization	Frequency
Increase number of admissions	26	Reduce costs by reducing inventory	17
Improve capacity	19	Improve productivity of personnel	13
Improve productivity of nursing personnel	24	Increase revenue by improving registration	11
Improve productivity of medical personnel	10	Improve utilization of equipment by use of ICT	10
Reduce unnecessary use of diagnostic tests	5	Improve process of purchase and maintenance	9
Patient satisfaction	2	Improve utilization of outpatient clinic	7
Improve safety	4	Improve productivity of secretary personnel	6
Total	**90**	**Total**	**73**

Table 6.1 Number of projects, September 2007-December 2011.

The finance department calculated that the financial benefit of all projects amounted to some €15 million. Exact figures are hard to obtain, however, owing to the oblique financial structure.

Two years after the introduction of LSS, management decided to go along without external help. The master black belt was recruited and assigned the task of facilitating the LSS activities, including the training of new green belts. In the meantime a group of coordinating black belts has been arisen, not in a centrally organized group, but operating in their own sectors and departments. There have been stiff conversations about the organizational form for LSS, and the outcome was that a non-central organization felt most comfortable. The non-medical directors took upon them to solve all kind of tuning problems. The experience with the LSS projects was that related problems in different sectors or departments were very similar, with often-similar solutions as well. With a process view in mind, and from a distance (the helicopter view), this is not at all surprising. Owing to the dominating culture of the hospital (as a result of employees moving from one department to another) one might expect comparable results in different departments, and related causes, as well as related solutions.

For improvements to be implemented, however, it is really necessary for the employees involved to experience the problems themselves, and to design their own solutions. Projects were therefore "repeated" at different departments, wards or clinics. It really helps however, to have universally applicable measurements, such as the method described in Chapter 3, about "inappropriate hospital stay", which is valid for all hospitalized patients who are not in an intensive care unit. "It seems to be a kind of waste – doing projects "double" – but this contributes to higher chances of implementing solutions. In this regard healthcare is really different from industry, where improved processes may be obtained by new settings of a machine or other technical measures. Most improvements in healthcare require another way of working, new standards or protocols, and eventually new habits: a "culture change".

The Control phase of the DMAIC roadmap is concerned with preventing problems to recur. For a large part this deals with the same matter of a culture change. Within the LSS framework (belt and champion in the driving seats) and its project based approach (projects lasting five months at most) a widespread culture change is hardly feasible. To obtain lasting results the Lean philosophy and tools are useful, in particular the elements of visual management, working as a team, and continuous improvement (kaizen). The end of an LSS project is ideally the beginning of a never-ending continuous improvement journey for the whole team.

Since several projects dealt with related problems, be it in different departments, the desirability of overall solutions and measures became clear. Two examples serve to illustrate the point.

- The projects on nursing efficiency demonstrated a need for clearly defined functions, and general rules about staffing in relation to the number of patients and their needs. These matters can only be solved adequately in the form of guidelines and rules for the whole organization.
- Owing to the financial structure of the UMCG the projects on length of stay required central direction. Most projects analyzed that the ward needed fewer beds than available. Closing beds would bring only limited financial benefits, however, because staffing could not be reduced. A broader solution – combining the reduced beds of

several departments – was needed for substantial financial results. This is clearly beyond the scope of department managers, so eventually senior management had to interfere to force the cooperation.

6.3 Consolidation of Lean Six Sigma at the UMCG

When LSS was introduced in the UMCG, it was new and exotic, with the potential of being a hype. Five years later LSS appears to be anything but a hype. The method is heard of in most parts of the organization, although for many employees LSS is still rather exotic. For management LSS represents an obvious method to use for efficiency improvement. Indeed, within a current cost cutting program LSS is explicitly used to analyze processes and to eliminate waste. More than 100 people were trained in the LSS methodology, constituting a pool of black belts and green belts, to be employed for projects and process analyses, although no more than 10-20 of them are at any given time doing LSS projects or related work. Several managers within this group play a special role in "spreading the word" and "walking the talk".

LSS projects are less scattered now then in the beginning. Initially there were projects all over the organization, but the problem was to raise the results to a higher, organization-wide level. Now top management selects themes for improvement, and within a theme one or more LSS projects may be done. The organization also learned that LSS is not always the most suitable method, so alternatives are allowed – use of LSS is less dogmatic than it was in the beginning. Scattered LSS projects still happen, however, allowing the UMCG to discover new themes.

Each half year there is an in-house training for new green belts, but the number of students is significantly smaller than in the beginning. To maintain the pool of belts, however, new employees must be trained to replace the dropouts. With a few guests from other hospitals in the neighborhood there are some six to eight students per training. The outline of the training is equal to the green belt training of the external teacher, but tailored to the UMCG needs (less statistical analysis, more "Lean thinking") with UMCG cases only. With a new and separate workshop "Lean Thinking and Doing" all employees are targeted. Especially, co-workers of nursing departments, logistical departments, and laboratories are attracted to the workshop.

6.4 Process improvement at the department of Traumatology

The first LSS project at the Surgery/Traumatology department started in 2008. The goal was to reduce length of stay (LOS), with percentage inappropriate hospital stay as driver for improvement (Niemeijer et al., 2010). After this project the other main processes were analyzed and improved in following years. In Chapter 3 we presented results from October 2007 till May 2009. Results from the years 2006-2011 are shown in Figure 6.1.

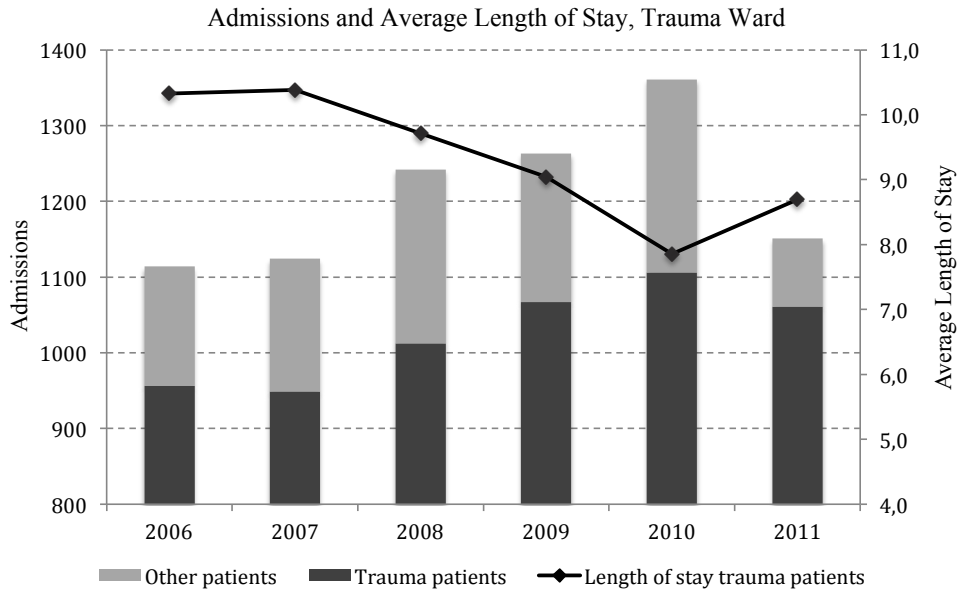


Figure 6.1: Admitted patients and average LOS at the Trauma Ward.

In the years 2008-2010 the average LOS decreased, and the number of patients grew. In 2011 the number of patients decreased with 15%, mainly because of 60% less "other" non-trauma patients (who cannot (immediately) be admitted at the most suitable ward). In 2011 the effects of LOS reduction projects at the other surgical wards were felt. The capacities of these wards increased, and fewer beds of the Traumatology ward were needed. The option to reduce the number of beds was not the first aim of the LSS project on the trauma department. Trauma surgery is an emergency specialism. Therefore, the first aim of reducing the LOS was to create more flexibility on the Trauma nursing department to accept all non intensive care

trauma patients from the emergency ward. So we reduced the number of patients who have been transmitted to other hospitals.

In 2011 the average LOS of trauma patients increased with more than 10%. The extra number of polytrauma patients (203 in 2011 versus 191 in 2010) may be responsible. Ultimately, the percentage inappropriate hospital stay measured by using the Dutch version of Appropriateness Evaluation Protocol (D-AEP) (Panis et al., 2002), can tell whether or not the increase of LOS is acceptable.

The measurement of inappropriate hospital stay is a very strong indicator of the efficiency of a department. Nowadays, this percentage is measured each day by one of the nurses of the Traumatology nursing department. The average over the year 2011 was 10%, which is lower again than the 12% reported in Chapter 3. Figure 6.2 displays additional but characteristic measurements of a week in March 2010 and 2011.

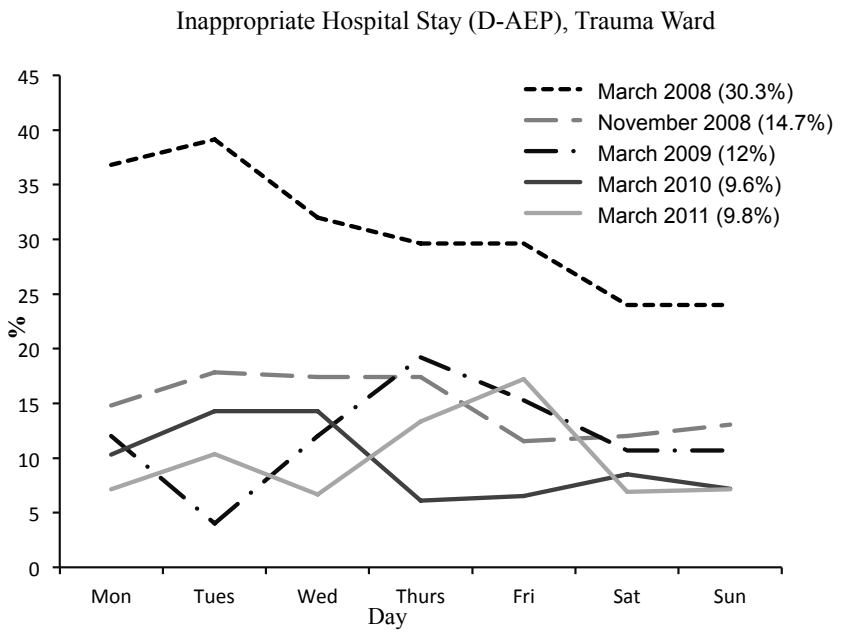


Figure 6.2: Some measurements of inappropriate hospital stay.

On the whole the results regarding LOS are much better now than they were in 2006 and 2007, before the process was improved. The average LOS of trauma patients is now less

than 9 days, and the production increased from 950 to (nearly) 1100. And most importantly for patients, the inappropriate hospital stay decreased from 30% to 10%.

The second LSS project, described in Chapter 4, started also in 2008 with the aim of reducing redundant diagnostic tests of trauma patients. The results of this project till December 2011 are shown in the control chart of Figure 6.3.

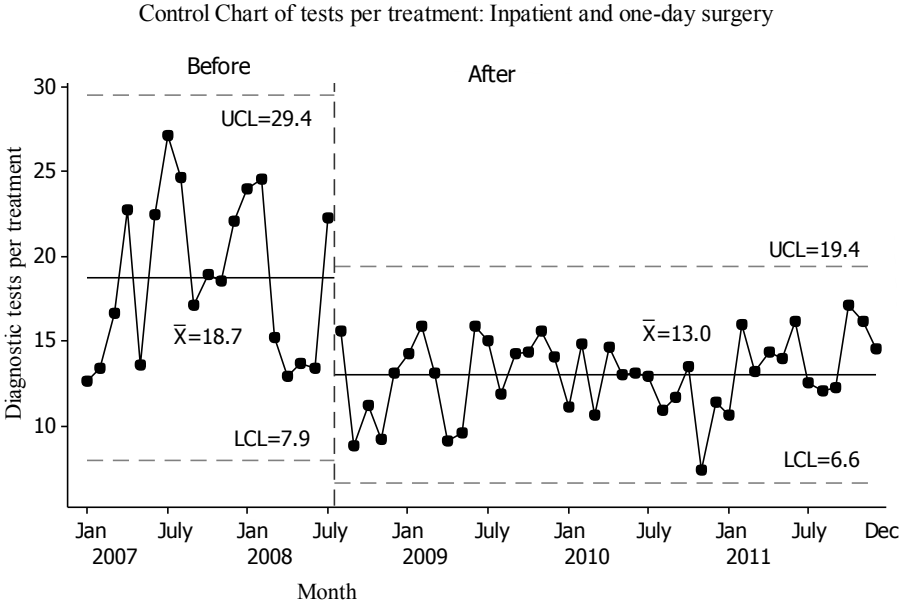


Figure 6.3: Average number of diagnostic tests per treatment before and after the interventions.

The average number of all diagnostic tests per treatment decreased significantly (p= 0.001) by 14.4%, despite the larger number of patients. At the (day) clinic the average number of tests per treatment decreased (p= 0.000) even more by 30.4%. Costs per treatment decreased on average with more than 10%. For the patient the most important achievement is that several redundant tests have been skipped.

The department of Traumatology also used LSS as a tool for efficiency improvement of a clinical pathway for elderly patients with a hip fracture, as described in Chapter 5. The gain for the patients is an impressive reduction of LOS from 13.5 days (standard deviation 10.2 days; N=137) before the project to 8.8 days in 2011 (standard deviation 8.2 days; N=308). The gain for the department is that these patients can be treated with fewer costs.

Apart from the described projects the Traumatology department hosted more projects to improve efficiency and reduce costs. In the second half of 2008 an LSS project aimed at reducing the cost of implants. Surgeons used their own type of implants and instruments during surgery, out of habit, or because they felt more comfortable with a specific type. After analysis of the data the project team decided to standardize the full set of implants and reducing stock. This result could be achieved solely because of leadership of the senior management of the department. The financial benefits of the project can be seen in Table 6.2.

Year	Number of day and inpatients	Number of surgical treatments	Cost of implants per patients (€)
2007	1937	1643	198
2008	1949	1786	182
2009	2194	1948	168
2010	2276	1894	182
2011	2388	2053	193

Table 6.2: Number of patients, treatments and cost of implants (2007-2011).

The reduction of costs in 2008 (compared to 2007) was achieved during the period August-December. Before the interventions in August the costs actually rose.

An LSS project in 2009 aimed at reduction of material directly related to the patient at the trauma ward, such as dressings, sterilized gauzes, and injection syringes. The project measured the amount of wasted material, which was kind of a shock to many nurses. As a result stricter procedures for ordering material were introduced. Moreover, a much cheaper contract could be signed with a single supplier of bandage material. The financial results of this project are shown in the control chart of Figure 6.4.

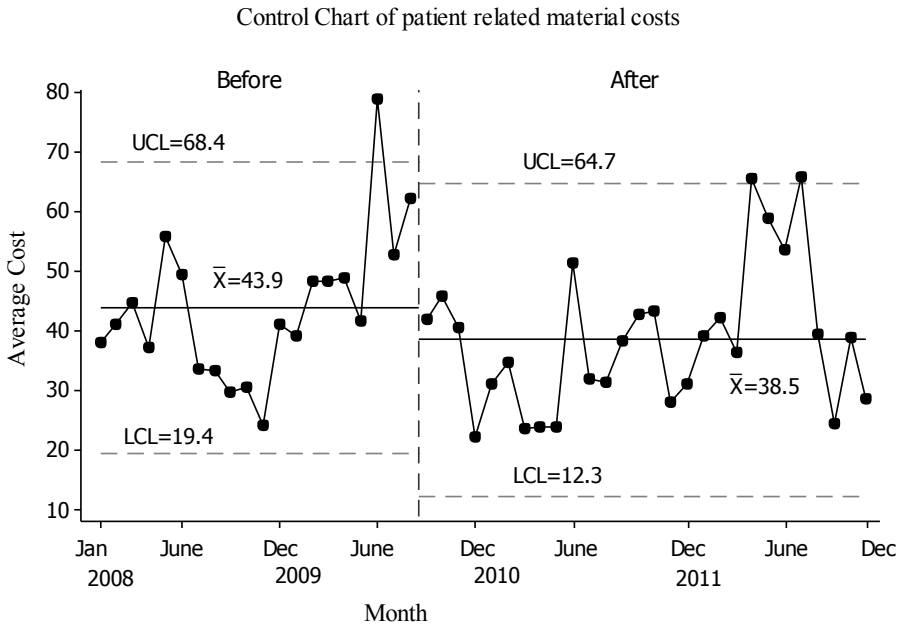


Figure 6.4: Monthly average cost per patient of patient related material (2008-2011).

The average cost per patient before and after the intervention decreased from €44 to €39. This is an interesting success, considering the fact that in recent years more material is used (e.g. for pain treatment for every patient) and more expensive material as well.

Other projects related to the department are the efficiency of nursing staff. Within the surgical clinic lack of personnel is now tried to solve with internal staff, instead of hired personnel. And finally, a project trying to improve the efficiency of the out-patient clinic can be mentioned. With tools from the lean toolkit interventions have been done with an emphasis on reducing waiting times for patients.

6.5 Conclusion

This thesis focuses on the use and impact of LSS in healthcare. Several processes in the hospital and all main processes of the Traumatology department have been analyzed and improved according to the framework of DMAIC. The cases of the Traumatology department show that LSS can be applied to several types of processes. We may conclude that quality

improvement for the patient and financial benefits for the organization are really two sides of the same coin. The cases also illustrate the value of the "mediation model for Six Sigma" (Schroeder et al., 2008), with leadership as an driver element, what should lead to strategic project selection and the use of improvement specialists and structured method (Figure 6.5).

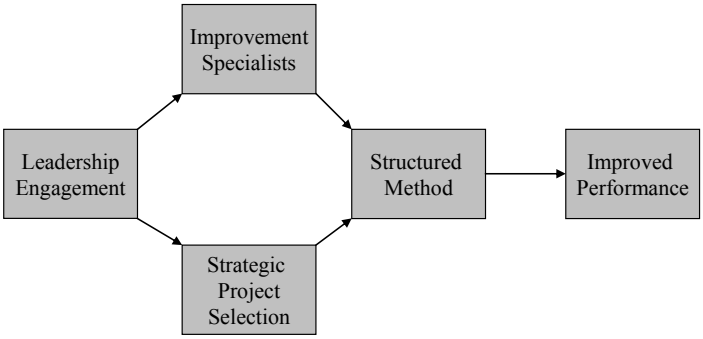


Figure 6.5: Mediation model for Six Sigma (Schroeder et al., 2008).

Leadership engagement is a *conditio sine qua non*. Senior management was prepared to support the new and stricter procedures for surgeons and physicians. Without their support not a single project would have succeeded. Senior management was also responsible for project selection, identifying processes with a need to be improved. Looking at processes with an eye for improvement needs special skills not normally present in healthcare employees. Therefore every project was lead by an LSS green belt or black belt. The conscious choice to train employees as internal specialists to improve (care) processes in their own environment appears to be successful.

In the UMCG Lean Six Sigma was introduced mainly because of a major cost reduction program. The notion was that LSS would be useful to bring this unique program to a successful end, and at the same time lay the foundation for future improvements in a financially healthy organization. Our claim is that these results were achieved, except for the "financially healthy" part. Much more severe cost reduction is needed now and in the near future, owing to the bad financial state of the Dutch government. The introduction of LSS, however, aided the transition of the organization from purely problem oriented to a more process oriented, which in turn is helpful in eliminating waste and finding solutions for difficult problems. The organization is therefore well prepared to face the challenges of the near future.

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SAMENVATTING

PROCESVERBETERING IN DE GEZONDHEIDSZORG

Wereldwijd is er discussie over de escalerende kosten van de gezondheidszorg waarbij vaak wordt aangenomen dat er een afweging moet worden gemaakt tussen investering in kwaliteit en kostenreductie. Mogelijkheden vinden om zowel de kwaliteit te verhogen en tegelijkertijd de kosten te beheersen lijken daarmee één van de belangrijkste gezamenlijke uitdagingen voor (medische) professionals, beleidsmakers en management.

Dr. Joseph Jurans definitie van kwaliteit als "fitness for use" biedt een goede conceptuele basis om zowel kwaliteit te verhogen als kosten te reduceren. Kwalitatief goede zorg voegt waarde toe aan wat de patiënt nodig heeft op basis van zijn/haar specifieke omstandigheden. Meer en kostbare behandelingen leiden niet noodzakelijk tot een betere kwaliteit van leven. Verbeterde technische behandelmogelijkheden bieden van origine de mogelijkheid tot een hogere kwaliteit van zorg, maar ze leiden in de regel ook tot kostenstijging. Het solitair hanteren van dit uitgangspunt van kwaliteitsverbetering leidt tot de opvatting dat het reduceren van kosten gepaard gaat met kwaliteitsvermindering. Dit onderstreept het belang van Jurans tweede definitie van kwaliteit als "reductie van fouten en gebreken" die de basis is voor procesverbetering. Het reduceren van fouten en gebreken in zorgprocessen leidt tot vermindering van wachttijden, complicaties, gebruik van personele en materiële capaciteit, en opnameduur. In de gezondheidszorg is er daarmee een economische relatie en directe verbinding tussen kwaliteit als "fitness for use" en de verbeterde proceskwaliteit en productkwaliteit van de behandeling.

De verschillende vormen van kwaliteit lijken uiteindelijk het best gerapporteerd te kunnen worden in termen van "gezondheidswinst", als indicator voor de mate waarin de behandeling voor de patiënt waarde toevoegt. Op dit moment vergt dat echter een investering in de ontwikkeling van relevante en gestandaardiseerde indicatoren. Certificering en accreditatie zou daarmee vervolgens van prominentere betekenis kunnen zijn in de beoordeling van kwaliteit binnen de gezondheidszorg.

Kwaliteitsverbetering is binnen een kwaliteitsmanagementsysteem een essentieel onderdeel, dat het beste tot uiting komt in een projectmatige aanpak. De selectie van geschikte projectdefinities is een cruciale factor voor het bereiken van verbeteringen. Hoofdstuk 2 beschrijft negen beproefde generieke projectmodellen voor procesverbetering in de gezondheidszorg. Deze modellen (of templates) zijn via een longitudinale onderzoeksmethode tot stand gekomen en zijn gebaseerd op 271 verrichte Lean Six Sigma projecten in de periode van 2002 tot en met 2009. Deze templates voorzien in een concretisering van projectdoelstellingen en operationele definities als basis voor procesmetingen.

In de daaropvolgende hoofdstukken zijn twee belangrijke generieke projecten gedetailleerd beschreven. Hoofdstuk 3 beschrijft de resultaten van een project ter verhoging van de efficiency in het gebruik van klinische beddencapaciteit. Door het aantal dagen niet noodzakelijk ziekenhuisverblijf te reduceren, wordt de ligduur van de patiënt in het ziekenhuis verminderd door de wachttijden zoveel mogelijk te elimineren. Het ziekenhuis kan de daarmee vrijgekomen klinische beddencapaciteit beter benutten.

Hoofdstuk 4 gaat in op het reduceren van het onnodig gebruik van diagnostische middelen. De toenemende variatie en beschikbaarheid van additionele diagnostiek dragen bij aan snellere en effectievere behandelingen, maar ook aan voortdurende kostenstijgingen. Het is dan ook van cruciaal belang dat behandelaars doelmatig gebruikmaken van de beschikbare middelen. Het verrichten van diagnostiek zonder klinische consequentie is potentieel schadelijk voor de patiënt en veroorzaakt onnodige kosten. De resultaten in dit hoofdstuk laten een significante reductie zien van het (niet noodzakelijk) gebruik van additionele diagnostiek.

Zorgprocessen bestaan vaak uit verschillende afzonderlijke processen die samen een zorgtraject vormen voor een bepaalde patiëntencategorie. De Lean Six Sigma methode bevat middelen en methoden om factoren die invloed hebben op de efficiency van deze (sub)processen te identificeren. Hoofdstuk 5 geeft een voorbeeld hoe een aantal van deze methoden gebruikt zijn om (in)efficiency binnen een zorgproces van patiënten met een heupfractuur te identificeren en te verbeteren bij de ontwikkeling van een multidisciplinair zorgtraject.

In het laatste hoofdstuk worden de resultaten van implementatie van Lean Six Sigma in het Universitair Medisch Centrum Groningen (UMCG) en specifiek daarbinnen bij de chirurgische afdeling Traumatologie geëvalueerd. In een periode van bijna vijf jaar zijn er binnen het UMCG 163 projecten verricht. Deze projecten hebben laten zien dat Lean Six Sigma gebruikt kan worden voor optimalisatie van verschillende processen en dat kwaliteitsverbetering voor de patiënt en financiële baten voor de organisatie twee kanten van dezelfde medaille zijn. De financiële baten van de projecten binnen het Lean Six Sigma programma zijn berekend op ca. €15 miljoen. De grootste winst voor het UMCG is echter de bijdrage aan een transformatie van een probleemgeoriënteerde naar een meer procesgeoriënteerde organisatie.

In een tijd dat er in toenemende mate vraag is naar kwaliteitsverbetering en tegelijkertijd naar beheersing en reductie van kosten, heeft het UMCG met Lean Six Sigma de beschikking over een bewezen toepasbare methode om deze uitdagingen aan te gaan.

Curriculum Vitae

Gerard Christiaan Niemeijer werd geboren op 26 augustus 1972 te Groningen. Na de middelbare school en de Hogere Beroepsopleiding voor Verpleegkunde vervult Gerard als dienstplichtig sergeant de taak van Hoofd Inwendige Dienst binnen de Militair Geneeskundige dienst. Zijn verpleegkundige carrière start in 1995 in het Martini Ziekenhuis in Groningen welke in datzelfde jaar wordt voortgezet in het Academisch Ziekenhuis Groningen binnen de afdeling Chirurgie – Traumatologie. In 2000 start Gerard met de opleiding Gezondheidswetenschappen aan de Universiteit van Maastricht wat in 2001 gecombineerd wordt met de functie van hoofdverpleegkundige van een gecombineerde verpleegafdeling Chirurgische Oncologie en Plastische Chirurgie.

In 2005 gaat Gerard een nieuwe uitdaging aan om als Physician Assistant aan het werk te gaan bij het aandachtsgebied Traumatologie. In deze functie maakt hij in 2008 kennis met Lean Six Sigma en volgt hiervoor de opleiding tot Green Belt. Na het afronden van een aantal succesvolle projecten wordt in 2009 het theoretisch examen “Black Belt for services” van het Instituut voor Bedrijfs- en Industriële Statistiek van de Universiteit van Amsterdam (IBIS UvA) met succes afgelegd, hetgeen in 2010 een vervolg krijgt met het behalen van het certificaat Master Black Belt (IBIS UvA).

Deze theoretische kennis is in praktijk gebracht tijdens het verrichten van meer dan 15 Lean Six Sigma projecten binnen het Universitair Medisch Centrum Groningen en het adviseren van andere projectleiders in de periode 2008-2011. Het onderzoek in de periode 2009-2012 naar de effecten van (deze) projecten en procesverbeteringen in de gezondheidszorg is de basis van dit proefschrift. Sinds 2011 is Gerard werkzaam als Programma Manager Lean Six Sigma in het Martini Ziekenhuis in Groningen.