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INTRODUCTION

We appreciate the opportunity to comment on the paper of Bo Bergman, Andreas Hellström, Svante Lifvergren, and Susanne Gustavsson (2015). They describe the emerging science of improvement in health care and add their perspectives from the quality improvement initiatives originating in industry.

Since 2000 we have been highly involved in process improvement in health care. We observe that a number of incidents that occurred in the last couple of years indicate that patient safety in hospitals is not satisfactory. In addition, increasing costs, quality problems, and long admission times are regular news items. Some people are of the opinion that hospitals are not in control of their operations and that they can learn a lot from car manufacturers, such as Toyota. Others think that hospitals cannot and should not be compared to a car factory. And then there are the numerous methods for improving the operation that have been offered to hospitals by consultancy agencies, such as Lean, Six Sigma, and the theory of constraints. In the following, we explain our views of improving operational effectiveness in health care.

HEALTH CARE PROCESSES: CAN A HOSPITAL BE COMPARED TO A CAR FACTORY?

The central mission of a hospital is to deliver good health care to patients within financial restrictions posed by society. Discussions and thoughts about the management of a hospital should be subordinate to this mission.

Good health care partly consists of effective methods for diagnosis and treatment. The required knowledge to design and apply these methods comes from medical science. We believe that medicine, including medical statistics, is a rather mature science. In addition, these diagnostic and treatment methods have to be delivered to patients, and this is done by various processes: medical processes, medical support processes, and nonmedical support processes.

Because medical science acquires knowledge about diagnostics and treatment, the science of operations management acquires the knowledge to design, control, and improve processes (see Figure 1).

Operational effectiveness qualifies how well processes in an organization perform, and operational excellence expresses the ambition of organizations to do this extremely well. We believe that it is in health care operations management, rather than in medical science, that the fields of quality and industrial statistics

can make a valuable contribution. But for this ambition, a pressing question in need of a good answer is: Are processes in health care comparable to processes in industry? The answer is not straightforward because processes differ. Some processes, such as the kitchen of a restaurant, are not visible for customers (unless it is an "open kitchen"), whereas in other processes, such as serving customers in a restaurant, the customers participate actively in the process.

Some processes, as in a fast food restaurant, deliver large volumes of standard products or services with little variety, whereas in other processes activities greatly vary from one job to the next and, at the other extreme, some processes deliver one-of-a-kind products and services (e.g., a personal chef who can prepare a completely tailor-made meal). For some processes there is a constant or at least predictable demand, whereas for other processes, dealing with variation and unpredictability of demand is a great challenge.

An assembly line in a car plant can be characterized as low visibility (no direct participation by the customer), high volume and low variety (virtually the same sequence of activities for each job), and low variation (relatively constant demand). A lot of processes in a hospital are significantly different from a process in a car factory and therefore should be designed and controlled differently. The same applies to numerous processes in other lines of business, such as the catering industry, airline companies, and the recreational industry. Many processes in health care are different from an assembly line, but they are by no means unique. They fall within the normal spectrum of process varieties in professional organizations.

OPERATIONAL EFFECTIVENESS: PROCESS IMPROVEMENT IS A SERIOUS PROFESSION

Operational effectiveness refers to the performance of processes in an operation (see Slack et al. 2013). In general, this refers to the performance in five generic dimensions:

- Quality: Meeting the needs and wishes of patients: effectiveness and suitability of medical care, courtesy, expertise and skills of the specialist, quality of the service, et cetera.
- Dependability and safety: Failures, mistakes, rework, punctuality, keeping promises, accidents.

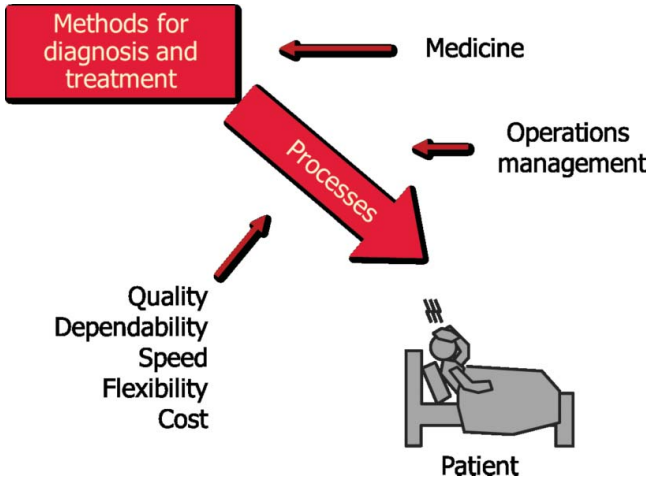

FIGURE 1 **Operations management is the science that studies how effective and efficient processes are realized.**

- Speed: Throughput time, waiting time, time of treatment, admission times.
- Flexibility: Ability to adapt the process to changes in demand (fluctuations in workload, specific needs of patients, range and customizability of services offered).
- Cost efficiency: Efficient use of man-hours, facilities, material.

Without doubt, everybody has ideas on how to achieve such performance improvement, but to improve networks of processes is more intricate than many people realize. Operations and processes in hospitals are a complex and dynamic system, just like a human body. Diagnosing problems in processes, and designing appropriate interventions, requires expert knowledge, just as the diagnosis of medical problems requires the expertise of a medical specialist. Unfortunately, many professionals with limited expertise regarding operations management have an opinion on how to improve patient safety, cost efficiency, and admission times. There are also many consultants who offer ready-made solutions, often copied from Toyota or from other emblematic examples from industry.

Finally, we notice that the discussion is often hijacked by defensive reasoning: the discussion focuses on justifying and explaining why operational effectiveness in health care is so difficult to realize, instead of looking for solutions to take actual steps forward. We strongly believe that a more constructive disposition is needed: actively looking for improvement instead of justifying and explaining why operational effectiveness in health care is difficult. There is no need for

reinventing the wheel: beyond health care, operations management is a mature field of study that has constructed an impressive body of knowledge. In the last couple of years, many professionals in health care have been trained in Lean and Six Sigma, such as Green Belts and Black Belts. In this way, hospitals invest in knowledge about operations management and they train their own professionals as experts in this field.

WHAT SHOULD WE THINK ABOUT LEAN, SIX SIGMA, THEORY OF CONSTRAINTS, AND SO FORTH?

Lean originates from the famous Toyota Production System, a revolutionary way of working developed by Toyota in decennia after the Second World War (cf. Shingo 1989). Toyota optimized processes to a synchronized flow with the purpose to convert materials into end products in minimal throughput time and with minimal inventory or other buffers of materials. In order to achieve that, it was necessary to go very far in eliminating variability, disruptions, and unpredictability from processes. This streamlining is applied widely in health care. A modern definition is: "A lean process is a process without waste, that delivers efficiently and smoothly what customers need."

First a process is streamlined and rationalized: hectic and chaos are eliminated by an improved organization and facilitation, thus making the work reproducible. Furthermore, tasks are scrutinized as to whether they add sufficient value to warrant the cost and effort to perform them. It is often an eye-opener when people notice that many tasks have no added value, although they have been carried out for many years. Finally, Lean looks for a balance between workload and capacities of the resources. The process is analyzed for bottlenecks, overcapacity, and the buildup of waiting queues. The amount of work-in-process is also important, because this determines the throughput time of processes.

The theory of constraints focuses on bottlenecks and controlling the work-in-process. This method, designed by Eliyahu Goldratt, offers principles for planning and scheduling of tasks and patients. It also teaches professionals to look for the main constraining factor in a process (cf. Goldratt 1990).

Lean often is an eye-opener for professionals, because people are often surprised to see how smooth and efficient processes can be if one takes the effort to turn them into an efficient clockwork. Lean is a more friendly alternative for achieving efficiency than the notorious stopwatch mentality: Lean achieves efficiency not by making employees work harder but by getting out of the way all the waste, inefficiencies, and disorder that keep employees from doing their work.

Where Lean and the theory of constraints mainly offer principles for operations management, the value of Six Sigma is complementary. Six Sigma offers organizational structures and methods for structuring problems and improvement initiatives and for pursuing operations improvement in a project-by-project fashion. This approach has been implemented in industry on a large scale in the 1980s and 1990s. Parts of this method can also be used in health care, especially because it offers a structure in which it gives the lean principles and theory of constraints hands and feet. Hence, the combination Lean Six Sigma. Project leaders, called Green Belts and Black Belts, are trained as experts in process improvement, and the belt degree refers to the weight of the training. Perhaps Six Sigma's most valuable contribution is the define–measure–analyze–improve–control (DMAIC) model, a subtle system of stages and deliverables, which helps the project leaders to structure the problem and to break it down into manageable pieces. The five main stages are (cf. De Mast and Lokkerbol 2012):

- Define: The potential benefits of an initiative are assessed and the project management structure is defined.
- Measure: Project objectives are translated into specific, measurable variables.
- Analyze: A diagnosis is made on the basis of data and measurements, so that the project leader understands the nature of the largest bottlenecks in the process.
- Improve: Remedies and solutions are designed, and their effectiveness is demonstrated before a choice is made ("evidence-based intervention").
- Control: The improved process is made controllable and structures are put in place for ongoing continuous improvement of the process.

In addition to the DMAIC method, Green Belts and Black Belts learn methods and techniques for data analysis and decision making.

Nowadays, Lean, Six Sigma, and the theory of constraints are used in health care on a large scale, and in some circles there is much debate about which method

is the best. We find such discussion unproductive and misplaced. Readers knowledgeable in operations management will recognize that all three methods build on extensive bodies of knowledge in this area of expertise. All three methods offer useful but highly simplified know-how. Books and consultants in Lean have a tendency to offer ready-made, one-size-fits-all solutions copied from Toyota, General Electric, or some other emblematic company. On the other hand, an expert in operations management will take into account the relative importance of the five generic performance dimensions for the owners and customers of the organization in question and will deal with the singularities and specific characteristics of the process under study.

HOW TO ORGANIZE THIS: BOTTOM-UP, TOP-DOWN, OR IN ANOTHER WAY?

Usually, Lean is being applied by means of small initiatives on the shop floor, whereby the employees themselves take the initiative to improve their processes. This way of working is called kaizen in Japanese: continuous improvement (cf. Imai 1986). An important advantage is that employees have an eye for the details and specifics that make process improvement difficult. External experts often have a sterile and too generic view of the problems on the shop floor. Furthermore, such a bottom-up approach stimulates commitment, helps in acceptation of improvement, and encourages a change of attitude and awareness. Employees develop an eye for waste and learn to act on it instead of accepting it as matter of fact. There are also significant disadvantages in the bottom-up organization of kaizen. Besides a change in attitude, kaizen often fails to achieve really substantial results. This bottom-up way of working often gets bogged down in futilities and trivialities and typically fails to deal effectively with taboos and sensitive issues ("trying to keep everyone happy"). We believe that substantial breakthroughs in hospital safety, reduction of admission times, and cost reductions can only be brought about by a way of working that challenges professionals to go beyond their comfort zones, focus on the truly constraining issues (the vital few issues, in Six Sigma terminology), and confront unpopular and sensitive issues.

This is the classical argument to hire external consultants. A top-down approach for process improvement works with experts from external consultant firms or staff departments. Typical advantages of a top-down way of working include that external experts can bring decisiveness, a fresh outlook on matters, an optimal design of processes without the lumber of the past, and a focus on major breakthroughs. But maintaining a productive atmosphere despite the stress and hostility caused by radical restructuring is a challenge, as is acceptation by shop floor employees who may feel alienated and not recognized.

Organizational economists (Jensen 1998) have proposed a subtle combination of bottom-up and top-down execution. Execution of improvement initiatives is organized in bottom-up fashion by making Green Belts from the line organization responsible, supported by teams of shop floor employees. But projects are ratified and reviewed by Champions, who steer on breakthrough results and offer political backup to tackle sensitive issues. In addition, a process is thoroughly redesigned using the DMAIC approach, but in the last stage (control), structures are laid down for facilitating an ongoing process of continuous improvement.

BREAKING FREE FROM THE DAY-TO-DAY ISSUES: IMPROVEMENT BY PROJECTS

Operations management distinguishes between acting on and adjusting day-to-day problems (control) and structural improvement of a process (improvement) (cf. Juran 1989). The first is reactive and is part of the regular task of employees. Standards such as the ISO-9000 series and Joint Commission International provide guidelines for organizing process control. Process control is important and inevitable, but some of the day-to-day problems are more chronic than incidental, and in that case control starts to resemble mopping with the tap running. Recurrent problems should be dealt with using process improvement, which means finding the problem and solving it. Many organizations have difficulties in finding a good balance between control and improvement. It is often difficult to make time for structural improvement because of the pressure of day-to-day problems. Breakthroughs can only be achieved if employee time is allocated to solving a specific problem; process improvement can only be done in the form of projects.

Four principles improve the probability of success in Lean Six Sigma projects:

1. Actionable: Problems are divided into projects that tackle a specific process and have a workable scope (e.g., 3 to 6 months).
2. Focus: It is easy to get lost in the multitude of issues that an organization faces. Only a limited number of issues determine where the organization will be in a couple of years. Most organizations get lost in the sheer multitude of projects and initiatives that they start and do not achieve any substantial progress. It is better to start with a small number of projects limited to issues with a very high impact potential.
3. Management by results: Initiate projects with a clear set of goals and evaluate progress and deliverables regularly.
4. Expertise: Projects are being managed by employees within the organization but only after they have been trained/educated in process improvement.

A guideline for the implementation is to start with waves of Green Belts who work on projects in their departments, aimed at strategic focal points such as patient safety, cost reduction, and reduction of admission times. Per strategic focal, point a Black Belt is assigned, who coordinates the work of the Green Belts in the various departments.

CONCLUDING REMARKS

We have been involved in improving health care processes since 2000. We have supported the implementation of Lean Six Sigma in many hospitals (cf. De Koning et al. 2006) and we have seen tremendous improvements. More than 600 documented projects show that effective health care processes lead to more reliable, faster, flexible, and cost-efficient health care. We have published these findings in leading international journals. Niemeijer et al. (2013) and Schoonhoven et al. (2011), for example, addressed the improvement of the patient's clinical path. De Mast et al. (2011) provide a model for the improved efficiency of resources such as magnetic resonance imaging or computed tomography scanners; Van den Heuvel et al. (2013) discussed the challenges of measuring health care quality; and Van Leeuwen and Does (2011) and Wijma et al. (2009) described projects aimed at increasing the efficiency of nursing departments. In their key paper, Niemeijer et al. (2011) classified hundreds of health care improvement projects to produce nine generic templates for the definition of such projects. In doing so, they provided a practical framework for project definition.

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