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Application of lean thinking to health care: issues and observations

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Abstract

Background. Incidents and quality problems are a prime cause why health care leaders are calling to redesign health care delivery. One of the concepts used is lean thinking. Yet, lean often leads to resistance. Also, there is a lack of high quality evidence supporting lean premises. In this paper, we present an overview of lean thinking and its application to health care.

Development, theory and application of lean thinking to health care. Lean thinking evolved from a tool designed to improve operational shop-floor performance at an automotive manufacturer to a management approach with both operational and sociotechnical aspects. Sociotechnical dynamics have until recently not received much attention. At the same time a balanced approach might lead to a situation where operational and sociotechnial improvements are mutually reinforcing. Application to health care has been limited and focussed mainly on operational aspects using original lean tools. A more integrative approach would be to pay more attention to sociotechnical dynamics of lean implementation efforts. Also, the need to use the original lean tools may be limited, because health care may have different instruments and tools already in use that are in line with lean thinking principles.

Discussion. We believe lean thinking has the potential to improve health care delivery. At the same time, there are methodological and practical considerations that need to be taken into account. Otherwise, lean implementation will be superficial and fail, adding to existing resistance and making it more difficult to improve health care in the long term.

Keywords: lean thinking, lean production, quality, health care, organizational climate, business process redesign

Background

In 2008, the death of a 47-year-old patient in a Dutch Mental Health care Institute led to a firestorm of protest. The subsequent investigation uncovered serious organizational and clinical quality problems, despite the Institute having a certified quality management system. Incidents and problems like this are a prime reason that policy makers and health care leaders are calling to redesign care [1].

One of the more popular concepts currently is *lean thinking*. On first sight, lean thinking seems an approach that generates positive results [2, 3]. But its application also leads to resistance. The argument is that business approaches like lean thinking neglect the sociotechnical aspects that are unique to health care [4]. In mental health care for example, some signal a risk of 'interference with the delicate therapeutic process and increased work stress and burn-out for professionals' [5].

A closer look at the results of lean thinking and other redesign studies also reveals other problems. Some commentators suggest that publication bias tends to highlight favourable results [6]. Despite this, a recent review identified only a few studies with a controlled before–after study design. To make matters worse, a wide range of often non-comparable measures was used, while some of the reported results were not even mentioned in the objective of the study and vice versa [7].

While some believe that lean thinking can contribute to health care improvement, much work has to be done to substantiate this claim. The purpose of this perspective on quality article is to describe an understanding of lean thinking and its application in health care.

Development of lean thinking

Originally, lean was developed as a production philosophy and quality system, with elements of both craft production and mass production. Lean thinking, with its emphasis on standardization, tries to eliminate inventory and improve processes. Time between a customer requesting a service and

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Table 1 The evolution of lean thinking (adapted from [8])

	Periods in the development of lean thinking			
	1980–1990	1990–mid-1990	Mid-1990–1999	2000+
Focus on	Production cell and line	Shop-floor	Value stream	Value system
Approach	Highly prescriptive, using lean tools	Highly prescriptive, imitating lean organizations	Prescriptive, applying lean principles	Integrative, using different management instruments
Industry sector	Automotive—vehicle assembly	Automotive—vehicle and component assembly	Manufacturing in general—often focused on repetitive manufacturing	High and low volume manufacturing, extension into service sectors
Typical activity in this phase	Application of JIT-techniques, 5s, kanban	Emulation of successful lean organizations training and promotion, TQM	Improving flow; process-based improvements, collaboration in the supply chain	Improving customer value to improve organizational alignment. Decrease variability

then receiving it is minimized. Various tools that together came to be known as lean production were first pioneered at the Toyota Corporation and were later used in the automotive, manufacturing and service industry and eventually health care (for an overview see reference [8]).

Since its introduction, the understanding of lean has changed considerably. Hines *et al.* [9] use the stages of organizational learning to demonstrate this evolution (Table 1). First, lean diffused to other automotive manufacturers (first stage) and later to other manufacturing industries (second stage). Because these manufacturers were relatively similar to Toyota, there was limited need to adapt the original instruments to these new environments [9]. Lean thinking was used in a highly prescriptive way, limited to the *application of shop floor tools*, e.g. *kanban* (a communication tool that authorizes production or movement), or *poka yoke* (a device that prevents incorrect parts from being assembled [10]).

Over the years, lean thinking evolved beyond applying Toyota's shop floor tools. This evolution was sped up by the description of Womack & Jones' five (operational) principles [11] (Table 2). The introduction of these principles placed customer value and waste reduction at the centre of lean thinking, but also fuelled the argument that process improvement and customer value came at the expense of working conditions of employees.

While the use of original lean instruments remains extensive, lean theory nowadays extends beyond its original operational aspects to include human behavioural aspects and the interface between these two. It is now argued that for any lean effort to succeed, both a quality system (operational) and a quality culture (sociotechnical) are needed [9, 12–14].

Understanding lean thinking

The key concept in lean thinking is 'value'. Value is defined as the capability to deliver exactly the (customized) product or service a customer wants with minimal time between the moment the customer asks for that product or service and the actual delivery at an appropriate price [11]. By defining 'what customers want', process-steps can be divided in value-adding and non-value adding. Value adding activities contribute directly to creating a product or service a customer wants. Non-value adding activities do not and are called waste. Of course, waste needs to be removed or avoided.

Table 2 Lean principles [10]

Five principles of lean thinking
Principle 1: Provide the value customers actually desire
Principle 2: Identify the value stream and eliminate waste
Principle 3: Line up the remaining steps to create continuous flow
Principle 4: Pull production based on customers consumption
Principle 5: Start over in a pursuit of perfection 'the happy situation of perfect value provided with zero waste'

Operational aspects of lean thinking

On an operational level, standard organizing tools like value stream mapping and 5S are available to create value (for an overview see reference [10]). Application of these instruments seems reasonably straightforward and they are discussed in most papers on lean thinking. Using them, hospitals have reduced waste in inventory, reduced waiting times (WTs) and improved productivity [15–17]. In some cases, these process improvements directly contributed to better quality care. In better organized wards for example, complications and infections may go down [18].

A well-known consequence of improving a single process is that problems shift to adjacent processes. In mental health care, timely out-patient follow-up after in-patient treatment is a well-known problem that causes patients to stay admitted longer, even in well-organized wards. That is why lean emphasizes a systemic, holistic view of process improvement. Application of lean thinking may initially focus on improving a single process (the ward) but needs to rapidly diffuse to the total value *system* (the ward *and* the following out-patient treatment), otherwise problems are not solved completely and will occur elsewhere in the system.

On an operational level, improvements are mainly achieved by reducing unwanted variation in processes. Variation is the degree of difference in the same process when repeated. Some variation is needed: surgical procedures are never done exactly twice; psychologists never have exactly the same consult with a patient twice. This is called natural variability. Natural variability is needed to effectively deal with individual differences between patients and their needs and deliver patient centred care. Artificial variability, on the other hand, is related to controllable factors in the design and management of health care systems [19, 20]. Counter-intuitively, artificial variability (how we have designed our health care system) may have a greater influence on health outcomes than natural variability. McManus *et al.* [21] found that the number of *scheduled* admissions (artificial variability) had a greater impact on overcrowding on an intensive care unit than the number of *unscheduled* admissions (natural variability). The fact that lean tools explicitly focus on removing non-value added activities (artificial variability) may explain some of the positive results that have been reported.

Sociotechnical aspects of lean thinking

Lean interventions have the potential to make jobs more simple and repetitive or turn them into jobs that require more thinking, planning and responsibility. These changes affect those who execute these processes (making jobs too simple or repetitive, for example, may lead to resistance and anxiety). Sociotechnical systems theory studies these interaction between social (human behavioural) and technical elements (technologies) [22].

The emphasis on lean as operational, process-oriented concept has directed attention away from these sociotechnical aspects. These aspects have been described as early as 1977 [23], but only recently has this 'respect-for-humans-system' received much scholarly attention.

Despite this, the sociotechnical influence of lean thinking on workers has been subject to explicit criticism. Much of this criticism has centred on the question how a technical system that explicitly promotes standardized repetitive work can still be attractive and motivating to workers. A common opinion is that even though lean organizations have some practices that seek to promote worker well-being (e.g. extensive training, internal promotion and pay for performance), 'respect' for humans is only a pleasant by-product next to higher productivity and quality [24].

At this point it is important to note that evidence on the effects of lean thinking on job characteristics is, according to some authors, 'largely anecdotal' and 'speculative' [13]. Rather than suggesting a simple cause–effect relationship ('lean leads to better work conditions' or 'lean deteriorates working conditions'), sociotechnical systems theory tries to explain which factors mediate these effects and how [13, 25]. From a sociotechnical perspective, application of lean tools automatically triggers further dynamics. Standardization, for example, makes jobs more simple and repetitive. These jobs may no longer be challenging to highly trained physicians. At the same time, this reduced complexity might make it possible for these jobs to be executed by less highly trained professionals, thus freeing up physicians to deal with more complicated patients. This simple example shows that, without taking into account these dynamics and redesigning responsibilities as well, lean interventions will indeed have negative effects on job characteristics.

Cumulative capabilities

We have elaborated on the importance of both operational and sociotechnical aspects of lean thinking. Some lean advocates even propose that carefully balancing operational and sociotechnical aspects can produce improvements that cannot be achieved by operational or sociotechnical interventions alone. They argue that this synergy accounts for the superior performance of lean organizations. The term 'cumulative capabilities' is used when high performances are achieved in multiple areas, like quality, speed and flexibility [26] on the one hand and working conditions and organizational climate on the other hand. A cumulative capability occurs when the introduction of a care pathway leads to shorter admission times (operational aspects), while maintaining a positive organizational climate (sociotechnical aspect) and achieving better outcomes, rather than trading off a shorter admission time at the expense of workers' satisfaction.

Definition of lean thinking

Based on the explanation above, we will use the term lean thinking, to denote (Figure 1):

> *An integrated operational and sociotechnical approach of a value system, whose main objectives are to maximize value and thus eliminate waste, by creating cumulative capabilities.*

Application of lean thinking in health care

In health care, value consists of a 'bewildering array of value-concepts, reflected in a plethora of quality measures and frameworks' [27], where different actors have different views of value [28]. Oftentimes, improving value for one actor leads to deterioration of value for another actor. To compare different kinds of value and determine the optimal balance, general measures like QALY's or willingness to pay can be

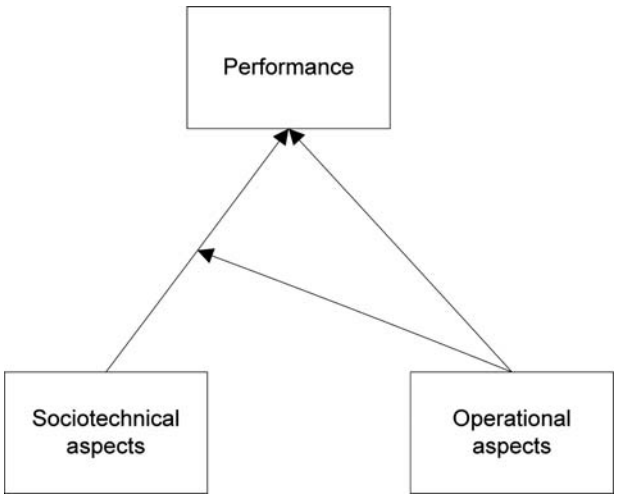

Figure 1 Conceptual framework of lean thinking.

used [27]. The premise in this line of reasoning is that quality is an individual level concept (the *doctor's* clinical value vs the *managers'* operational value).

Lean takes another point of view. Value is not seen as an individual level concept, but as a system property. According to lean, a system has an inherent, maximal value that is bounded by its design, rather than by the will, experience or attitude of individual members. If value is suboptimal for any stakeholder, the point of leverage is the system, not the individual [29]. Berwick [30, i3] illustrates this with the example of the top speed of an automobile: 'a person displeased with his/her car's top speed is fully entitled to get angry at the car, to give it incentives to go faster or to put an incident report in the car's file (. . .) A driver who wants to go faster is going to need a different car. So it is with [value]: the mortality rate of a specific hospital, the preservation of FEV1 in a specific group of children with cystic fibrosis (. . .) is a property of the existing system at work'. In other words: if value in a system is to be improved, the operational and sociotechnical aspects of that system have to be improved.

Operational aspects of lean thinking in health care

Most lean implementations start with the introduction of lean instruments, aimed at redesigning operational aspects of the care delivery process [2, 3, 15, 16]. Such an approach is suitable in some organizations. A more integrative approach would be to search for instruments already available in health care, which are also in line with lean thinking, for example Care Programmes and Integrated Care Pathways. Both can be based on patient-in-process analyses.

To improve on an operational level, lean makes a distinction between value and non-value adding activities. To achieve this, a 'patient in process analysis' [31] can be helpful. In this analysis, a patient's journey through a health care system is analysed based on different categories (Table 3), identifying non-value adding activities. The results can be used as a starting point for further improvements.

Another example of an instrument in line with lean is a 'Care Programme' [32]: all specified and coordinated activities and measures, to deliver health care services or to reach certain effects in a specified target population. In lean terms, Care Programmes focus on a whole value system. Care Programmes have shown to be effective in reducing symptoms and improving patient satisfaction [33]. The development of care programmes requires organizations to clearly define the interventions that are included in the treatment of a specified target population and to measure the effect of these interventions. Even though Care Programmes have not been developed as part of a lean implementation effort, they help organizations to take a systemic view on improving performance, something lean thinking promotes.

Table 3 Value and waste examples in health care (adapted from [31])

Lean thinking	Health care
Value adding time	Diagnostic and care time • Diagnostic time (collecting and analysing clinical information) • active care time (clinical interventions) • passive care time (under observation, no interventions) WT • positive WT (patients condition is likely to improve without interventions)
Non-value adding time (waste)	Diagnostic and care time • Superfluous time (not needed diagnostics, observations or interventions) • administrative time WT • passive WT (no change in patients condition is expected) • negative WT (patients condition is likely to deteriorate)

Integrated Care Pathways are another example. Their use in health care is widespread and developing them [34] has many similarities with the lean instrument value stream mapping [35]. Pathways can be used to optimize Care Programmes, the same way value stream mapping can be used to optimize value systems [32]. Even this limited and rather arbitrary set of instruments shows that most health care organizations are already using instruments that are in line with lean principles.

Sociotechnical aspects of lean thinking in health care

A limited number of lean interventions deliberately include sociotechnical aspects. While operational improvements are reported in detail, sociotechnical improvements are described in general terms. A report on implementing flow in wards serves as an example: 'the number of outliers (patients in wards not related to their condition) has halved, patient turnover has increased 20 per cent, with the median length of stay reduced by one day. At the same time, there has been greatly improved opportunity for team work, better communication between specialists and the development of a nurse team skill-base appropriate to the condition' [17]. With some exceptions [18], most lean implementation efforts are aimed mainly at improving operational efficiency and only secondly take into account the sociotechnical effects of their interventions.

Even in mainstream lean literature, attention to sociotechnical aspects is recent [12] and adjusting these insights to health care takes time. At the same time, sociotechnical systems theory can provide a framework for those who want to improve health care delivery [22]. This requires a substantial shift of mind, especially at the managerial level. Successful sociotechnical improvement requires managers to realize their job is *not* to improve care processes. That is the role of the professionals actually working in care processes. A manager's role is to improve and develop his or her own workforce. A manager's most important task is to create an environment where interaction between team members leads to a level of performance that can not be achieved by individual team members alone [12, 30].

Such an approach starts with collecting and using information on organizational climate, learning and problem solving skills within teams. Based on this information, teams themselves need to decide if and where improvements are needed. Repeated measurements can be used to evaluate progress. This way, measures of organizational climate and learning become ingrained in an organizational Plan-Do-Check-Act cycle.

Cumulative capabilities in health care

Eventually, a balanced lean approach may lead to a situation where fewer trade-offs need to be made. This requires measures that describe both operational and sociotechnical effects of an intervention and their outcomes. This is only partially the case in current reports on lean in health care. At present, most papers seem to report operational improvements [16, 17, 36]. Less frequently, papers report on better outcomes, like health adjusted mortality [3]. Some report, in general terms, about sociotechnical improvements [36]. None, however, has clearly reported on all these aspects together or on cumulative capabilities.

Conclusions

In this paper, we discussed lean thinking as a management approach that focuses on operational aspects and the sociotechnical dynamics these improvement systems causes. We discussed how one can start to apply these insights to health care.

Reports on lean-related improvements in health care have led some to conclude that: 'the Lean message is 100 per cent positive. Lean can improve safety and quality, improve staff morale and reduce costs—all at the same time' [17]. Such an overly positive conclusion fails to take into account the variety of issues surrounding the application of lean thinking to health care.

One difficulty regards the sociotechnical dynamics that occur when implementing lean thinking. While reports on the importance of sociotechnical issues start to emerge, the multitude of questionnaires, outcome parameters and research designs used make it hard to draw general conclusions. Research on sociotechnical dynamics in lean organizations, especially in health care, is virtually absent.

Operational aspects of lean thinking and their link to performance have been looked at more thoroughly, but application to health care has been limited. The same goes for cumulative capabilities, where research in and out of health care is scarce. More attention is needed to verify these key propositions of lean thinking in health care.

While it is beyond the scope of this paper to discuss the methodological aspects of the evaluation of lean thinking, it is important to note that lean thinking is composed of a number of components, which act both independently and interdependently. Research on such complex interventions requires special methods and research designs [37]. Currently, case study designs are the most frequently used. While this design can provide useful insights, it has serious limitations regarding generalizability and inter-subjectivity. Along with the other methodological issues surrounding the evaluation of lean thinking, which we mentioned in the introduction [7], it is safe to say that not only more research, but also higher quality research is needed. At this time, to state that 'the lean message is 100% positive' [17] seems a bit of a stretch.

Even if these problems are addressed and lean delivers on its promises, the challenges to increasing the role of lean thinking are daunting. They require no less than the redesign of the health care system as we now see it. Perseverance, high quality leadership, dedicated professionals and patience are surely needed. Scepticism and resistance will be high, success not guaranteed. Organizations may think twice before embracing on such a journey, or worse, superficially implement lean thinking, adding to existing resistance and

making it more difficult to improve health care in the long term.

Overall, we support the possibilities lean thinking offers to improve health care. Lean is a hands-on improvement method, in line with suggestions made by leading authors on how to improve health care systems worldwide [38]. Yet, if lean thinking over the next decades will be hailed as the 'machine that changed the [health care] world' [39], more rigorous and balanced research and reporting is needed.

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