The applications of lean management in modern healthcare

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ABSTRACT

Emphasis on quality and reducing costs has steered many healthcare organizations to reform their whole philosophy changing their management, processes, and quality control infrastructures. Incidents and quality problems consist two of the main issues that indicate why health care leaders need to reform health care service. The evolution of production systems is closely associated with the story of Toyota Motor Company (TMC) that has its roots back in 1918. "Lean thinking" is one of the most revolutionary concepts that have been introduced. The term "lean" was coined in 1990 after the analysis of the Toyota model that led to the "transference" thesis supporting the idea that manufacturing issues and technologies are universal in all production systems and that these concepts can be emulated even in non-Japanese organizations. Lean is a versatile concept that urges organizations to increase their efforts in various levels at the same time. Some authors suggest that a successful implementation encompasses achieving main strategic components of lean, implementing practices to support operational aspects, or providing evidence that the improvements are sustainable in the long term basis. The implementation of lean principles and tools in healthcare has gradually led to a significant improvement in quality and efficiency. However, the transition to lean requires a substantial investment of time. This study investigates the challenges and opportunities faced by healthcare organizations that intend adopting a lean mentality.

Keywords: Lean management, improvement, quality, healthcare, waste.

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INTRODUCTION

Emphasis on quality and reducing costs has steered many healthcare organizations to reform their whole philosophy changing their management, processes, and quality control infrastructures. Lean thinking was initially used for improving operational shop-floor performance at an automotive manufacturer, and gradually evolved to a management approach with operational and sociotechnical aspects. Interestingly, sociotechnical dynamics have not received adequate attention until recently. Establishing an equilibrium between operational and socio-technical improvements could lead to their mutual reinforcement. Application of lean to healthcare has been generally restricted to operational aspects by using original lean tools. Enhancing the socio-technical dynamics of lean implementation efforts could facilitate a more integrative approach. Lean thinking has the potential to improve the delivery of

healthcare, but various methodological and practical considerations need to be projected.[1] Many processes of healthcare services need to be simplified. Lean thinking could create a more patient-centered philosophy to improve the quality and efficiency of modern healthcare. The daily interaction and collaboration of healthcare workers should be defined by unity and tendency for continuous improvement together with a maintenance of a solid ethical basis. Health leaders must inspire staff to adopt and maintain these values.[1]

The cardinal challenges of healthcare systems

For many decades there has been much debate on how to implement efficient affordable healthcare coverage for the population.[2] Nowadays, leaders are under firm pressure to resolve issues of multi-layered complexity that impacts the ability to successfully introduce cost-effective programs, maintain efficient operations and services, staff and trained employees, and support other healthcare initiatives. Healthcare leaders should be ready to encounter a wide spectrum of challenges including regulatory and policy modifications, technological and medicinal developments, as well as funding, ethical and educational issues. The plethora of these emerging challenges could rapidly lead to consumption

of resources; time and funds that could otherwise be utilized for research, training, equipment overhaul and facility upkeep. The constantly increasing needs of research indicates that technological development will trigger a chain of further challenges with programming, support and control matters. Implementation of new systems means that leaders need to train themselves, and their employees, so that they can use the new systems and services efficiently while maintaining their accessibility to the public.

The concept of lean management

Approximately 18 years ago, the investigations of the death of a 47-year-old patient in a Dutch Mental Healthcare Institute revealed numerous critical organizational and clinical quality issues, suggesting that healthcare leaders and policy makers need to reform care.[3] Additionally, rising healthcare costs together with increasing complexity of modern healthcare has led several healthcare organizations to reconfigure their management, process, and quality control infrastructures. Currently, one of the most popular concept for these reconfigurations is *"lean thinking".* At first glance, lean thinking is perceived as an approach that produces positive results. However, its application also leads to resistance. The main argument derives from the fact that approaches similar to lean thinking may not pay adequate

attention to the unique sociotechnical parameters of healthcare.[4] However, the concept of lean thinking remains a very promising approach with favorable outcomes for healthcare systems.

History of lean management

The evolution of production systems is intimately associated with the story of *Toyota Motor Company (TMC)* that has its roots back to 1918 with Sakichi Toyoda, who owned a patent for a revolutionary automatic loom for the weaving industry. In 1929, the company sold this patent and reinvented itself in the automotive industry, which at the same period was dominated in Japan by local subsidiaries of Ford and General Motors (GM). The production of trucks and cars began in 1935, and in 1937 TMC was formally incorporated. Interestingly, by 1950, the entire Japanese auto industry was manufacturing an annual output equivalent to three days of the US car production. It was around this time when Eiji Toyoda travelled to the US to study manufacturing methods. Another prominent TMC employee, Taiichi Ohno, joined the company in 1943 and accompanied Eiji Toyoda with his journey. His conclusion was the Western production systems had two major flaws:[5]

1. Producing components in large batches led to huge inventories

2. The methods preferred large production over customer preferences

Toyota Production System (TPS) gradually evolved and provided a tool that used innovation and common knowledge, and that functioned efficiently in an environment with different cultural principals in comparison with the Western hemisphere. It was not until 1965 that the system was also rolled to TMC's suppliers and TPS began to be documented. Surprisingly, it did not gain adequate interest until 1973 when the impact oil crisis expanded to the global automotive industry. This supported the concept that manufacturing issues and technologies are universal problems faced by management, and that these concepts can be emulated in non-Japanese enterprises. Therefore, lean was originally developed as a production philosophy and quality system, with features of craft and mass production. Since its introduction, the understanding of lean has evolved substantially.[6] Over the years, reports of Western companies accelerated the process of extension in diverse sectors, incorporating lean principles that involved:[6]

1. Identification of customer value

2. Management of "value stream"

3. Developing capabilities of flow production

4. Use of pull mechanisms to support flow of materials at constrained operations

5. Pursuit of perfection through reducing to zero, all forms of "waste"

The identification of *customer's value* was one of the most crucial points in shifting focus from the production floor, by adding product/service features while eliminating wasteful activities. "Value", a key concept in lean thinking, is defined as the capability to minimize the time between a customer requesting a product or service and precise delivery of the (customized) product or service at a cost-effective price for the customer. Therefore, it is tightly related to customer requirements and finally it is the customer that determines what constitutes muda (waste in Japanese) and what does not. By defining 'what customers want', process-steps can be subcategorized into value-adding and non-value adding. The concept of lean is multi-parametric and multi-faceted and calls for serious commitments and setting a strategy that affects the organization at all levels.[7] Two of the main questions are how to assess whether a company is ready to adjust to such drastic modifications and what it would be required to ensure that the transformative process will be successful. Perhaps it may be easier to respond to the following complementary question: What are the major reasons of failure in organizations that attempted to create a lean culture? The reasons include a lack of: (1) interest in lean (2) senior commitment (3) organizational

communications, (4) team autonomy, (5) organizational inertia.[7] Offering principles for theoretical efficiency, facilitates more production even with a smaller workforce, reducing the frustration among employees. Several studies have described formulas for implementation and lessons learned from failures,[7] underlining the importance of alterations at a cultural and behavioral level. Although all these parameters are framed in the realm of tangible business and strategic directions, the concepts of "cultural changes" and "endless improvement" remain abstract. Moreover, since the process is infinite, it is implied that there is no ceiling to successfully completing the task.

Lean practices should be perceived under the umbrella of their cultural origin. According to the Japanese management mentality, the main three characteristics are:

1. Harmony and group loyalty
2. Consensus in decision-making
3. Lifetime employment

These features are all encompassed in the sphere of "respect for people". Historically, this concept was not understood in the USA, as companies focused only on continuous improvement.[8] Consequently the main reasons of failure are not the technical issues related to the implementation of lean thinking, but principles that constitute a greater composition. There are distinct steps and stages in the lean culture implementation,

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such as establishing priorities in areas or projects that need to be restructured. However, the cultural adjustments consist of an endless process that may be too complex for many companies, underlining the need of deep structural modifications.

The link between lean and healthcare industry

The principles of lean production and management can be applied in healthcare, although they were initially designed for application in other industries. As previously mentioned, lean philosophy calls for creating values and increasing efficiency through elimination of waste **(Table 1)**. Interestingly, these wastes are not unique to healthcare as they are commonly found in all industries.[9]

Patients must be at the centre of attention, whereas time and comfort should play a pivotal role as performance measures in the system. The patient, who is considered as the primary customer, requires a conceptual leap; although customers typically pay directly to the enterprise, in healthcare, the third-party handles payments depending on the level of insurance applied in the vast majority of cases. The value is related to the customer needs and it will be the customer who finally determines which processes are wasteful. Consequently, it becomes evident that patients' demands may call for changes even pertaining to activities not be directly related

to their care. Some initial attempts to applying lean principles in healthcare were nothing more than an exercise to transfer manufacturing principles to reduce physical inventories in hospitals. Later however, the following types of implementation were described:[10]

1. Manufacturing-like studies
2. Managerial and support case studies
3. Patient-flow case studies
4. Organizational case studies.

The levels of implementation can be categorized at three levels:[10]

1. Micro-operational level outcomes represented by manufacturing-like, managerial and support, and patient-flow cases
2. Meso-strategic level that focuses on financial health of organizations, with potential outcomes being financial, staff morale and involvement
3. Macro-outcomes of national initiatives such as the National Health Service plan in the UK

Notably, the implementation of lean principles in healthcare became more popular in the USA and Europe.[8] Challenges regarding lean implementation in healthcare are closely associated with the concepts of value, metrics, and evidence. There is strong evidence that healthcare in the USA is not patient-centered, does not provide timely services, is not equitable and lacks of efficiency, whereas

many patients are under-insured.[11] The concept of reforming and redesigning such a system, especially around basic values, using evidence-based tools, emphasizing clinical and services outcomes, and adopting rigorous quality improvement methods is obviously a phenomenal challenge that is imposed at the macro or even the meso-strategic levels.

It has been suggested that lean implementation should be initiated at the microlevel. In that scenario, if it is decided to implement a lean project only for a specific area, then the definition "senior management" will eventually turn out to be the "senior management of the specific area" where the implementation is carried out. On the other hand, a more holistic approach that should be linked at a larger level will rather be a process/unit/department that designs improvement stages, in the frame of a larger cluster of departments or even at an institutional level.[12] At this level, communication and problem solving will be simpler and faster as mid-level managers have to control and supervise only their allocated areas, whereas CEOs or Chief Medical Officers have to address a myriad of problems overarching the institution. Finally, the patients (customers) of a particular division may be defined by unique features that may differ with other patients of the same institution.

Resistance to change, is in most cases associated with a lack of executive support.[13] Nevertheless, adopting a bottom-to-top approach can redefine the responsibility of the institution's senior management to the following three main strategic divisions instead of dedicating huge amount of time, energy, and resources to the lean process: (1) recognize the "vital few" areas that will benefit most from implementing lean, (2) be committed to allocating the supporting resources necessary for the required modifications, and (3) be in charge to ensure effectively communicate the results of the alterations to the stakeholders of the organization.

Instead of focusing only on operational points of view of lean culture, unit managers will be able to reconcile projects and activities with socio-technical aspects that respect the "human system", taking into consideration the impact of the changes on the staff and the people that they interact daily with. Therefore, in order to create "cumulative capabilities" and value, managers at all levels need to comprehend that apart from only improving the processes, developing the departmental job-force is also part of the implementation.[8]

Lean healthcare implementations

The first step for reducing waste is to recognize the value of added steps in every

process, accurately specifying those in the value stream map. After defining the wastes, they can be eliminated by using lean principles and tools **[Table 2]**.[14] Lean thinking initiatives in healthcare sector, show positive impact on productivity, cost, quality, and timely delivery of services due to the application of lean principles at various levels of organizations. The value in healthcare is defined by the efficiency of curing or relieving the patients' pain. The process of achieving this final goal is defined as patient flow in healthcare and is associated with physical goods like drugs, pharmaceuticals, medical devices and health aids, as well as with all stages of patient's treatment (from referral to full recovery).[15]

The annual rise of the number of publications about lean healthcare implementation indicates the increasing interest of lean healthcare worldwide. Special emphasis has been given on organizing multi-skilled teams that take care of the patient, but also on patient's active involvement in the process. Front line staff tend to make quality improvements driven by their perceptions of what needs to change and what can increase work satisfaction (based on immediate feedback on efforts). Subsequently, the whole process is about creating new work rather than destroying jobs in the name of efficiency.[5]

In healthcare, focusing on zero defects, continuous improvements, and Just in Time (JiT), makes lean production especially applicable. There are several tools that can be used to practice these principles. For instance, Kaizen blitz, [also known as rapid improvement event (RIE)], value stream mapping (VSM) and the six S's (Sort, Straighten, Shine, Standardize, Sustain, Safety – also referred as 5S's) are facilitated for reorganizing the working place.[16]

RIE consists of a five-day workshop aiming to detect problems in the existing processes to indicate small and quick modifications. Typically, it has three distinct phases, starting with a preparation period, followed by the event and a three-to-four-week follow up period for implementing the alterations. On the other hand, VSM contributes in eliminating wasteful activities by supporting the active participation of all appropriate factors. These include all those involved in the several steps along the patient journey. Firstly, it is critical to explore and map out how the process currently operates and secondly, to recognize waste and delays and enable error visibility via daily audits. Moreover, the map must provide an analysis about the accessibility to healthcare, patient participation and interaction with the healthcare organization. Finally, the flow map must be available for the healthcare team so

that all steps of every process will be visually accessible.[16]

Overall, value consists of a perplex array of value-concepts, reflected in a wide spectrum of quality measures and frameworks, where different factors have different perception of value.[17] Very often, improving value for one factor is a comprise leading to the deterioration in value for another factor. In order to compare different kinds of value and define the optimal balance, general measures (e.g. quality-adjusted life-year (QALY)'s or willingness to pay) can be employed.[17] The precondition in this line of syllogism is that quality is an individual level concept (i.e. the doctor's clinical value vs the managers' operational value). However, lean offers another point of view; value is not perceived as an individual level concept, but as a system property. More specifically, a system has an inherent, maximal value that is determined more by its design, rather than by the will, experience or attitude of individual members. If value is suboptimal for any of the stakeholders, the point of leverage is the system, not the individual. This means that if value in a system needs improvement, the operational and sociotechnical aspects of that system have to be improved.

Operational aspects of lean thinking in healthcare

The majority of lean implementations are initiated with introducing the lean tools, aiming to redesign operational aspects of the process of care delivery. This approach is considered to be suitable in some organizations, whereas a more integrative approach encompasses searching for instruments already available in health systems, most of which are also in line with lean mentality (e.g. Care Programmes and Integrated Care Pathways). In order to improve at an operational level, lean distinguishes value and non-value adding activities. For this cause, a 'patient in process analysis' could be of benefit. In this particular analysis, the patient's journey via the healthcare system is analyzed based on different categories, detecting non-value adding activities.[6]

Another example of an instrument compatible with lean is a 'Care Programme'. All activities and measures that target to deliver healthcare services or to bring certain effects in specified target population, focusing on a whole value system, are particularly important. Care Programmes were found to be effective in ameliorating symptoms and increasing patients' satisfaction.[18] The development of such programmes requires clarifications of the interventions that are included in the treatment of a specified target population and measurements of the effect of these interventions. Although Care Programmes

have not been developed as part of a lean implementation process, they contribute in the organizations effort to attempt a systemic overview on improving performance, similarly to lean thinking.

Sociotechnical aspects of lean thinking in healthcare

A limited number of lean interventions consciously encompass sociotechnical aspects. Whereas operational improvements are thoroughly described, sociotechnical improvements are mainly reported in general terms. The majority of lean implementation efforts target to improve primarily the operational efficiency and at a second degree the sociotechnical results of their interventions. The interest towards the sociotechnical aspects is quite recent, while the adjustment to this new prospect requires time. The theory of sociotechnical systems can create a framework for improving the delivery of healthcare.[19] This procedure requires a careful collection of useful information about the organizational environment, continuous learning and problem solving skills among teams. According to this approach, each team needs to recognize what types of improvements are required. Repeating measurements is necessary for evaluating progress, so as to create a "Plan-Do-Check-Act" cycle.[6]

Cumulative capabilities in healthcare

At a long-term basis, a balanced lean approach can create a situation where less trade-offs need to be made. Both operational and sociotechnical effects of an intervention and their outcomes should be measured carefully. Currently, most studies tend to report operational improvements[20] and less frequently, studies report on better outcomes, like health adjusted mortality. Only some report about sociotechnical improvements and mainly in general terms .[20] None, however, has clearly reported on all these aspects together or on cumulative capabilities.

Facing the challenges and overcoming barriers in the implementation of lean in healthcare

Spagnol et al.[16] suggested a classification of barriers related to lean implementation in three moments: (1) the first impression (initial approach) (2) implementation process, and (3) lean thinking maintenance. With regard to the first moment, many lean projects are developed at departmental level (47%), and even organizations defined by a lean focused administration still have a long way to go until they reach the ideal of complete accordance with the principles. More specifically, there are only few attempts of introducing lean thinking throughout the whole organization. Characteristically, Snyder and McDermott[21] described the support

offered to a department by a successful lean organization as a critical tactic that reduces common pitfalls during early stages. This facilitates higher reliability on lean thinking due to staff members having successful implementation as a model. Interestingly, the Danish Study underlines that the way lean implementation is negotiated with employees (since the first moment and until the process is fully developed), may also act as a great barrier to its efficacious implementation. As expected, not all members share the same goals and values, and this may not lead to an absolute adherence to lean principles. Presenting results from other organizations and inviting senior-level leaders speak in terms of years of commitment to Lean have been described as two effective tactics used by hospitals in order to face this issue.[22] Showing quick visible results after lean implementation, especially those that directly affect employees' satisfaction (e.g. reducing staff turnover or workload), is a good way to involve people. Lean thinking focuses on freeing resources to improve what is important, which is in stark contrast to the misconception of reducing staff in terms of lean implementation. Another obstacle was to gather all "decision makers" professionals in weekly meetings, as their agenda was overbooked.[23] Although organizing a meeting schedule may seem like a simple issue, it can be a potential barrier to a successful debate

and affect the continuous development of lean healthcare. Involving professionals from different departments is pivotal due to their specific knowledge and their reality empowerment about their department's process; something that is crucial during a value stream map construction. Consequently, all employees must be trained in order to comprehend the organization's strategy, their role and personal goals, as well as the timeline to accomplish the development plan. During phase (c), organizations must be ready to maintain the new management mentality, and this calls for workload adaptation to new responsibilities and time investment. Another common mistake is not to dedicate adequate time for lean activities and this can lead to undue frustration in face of poor results. Finally, it must be emphasized that lean thinking is more substantial than a quick modification, as the organization has to form internal competences in lean management and implementation in terms of the changing process.[23] In order to successfully maintain the principles, the agents implementing the changes must remain on leadership until lean mentality is embedded in the culture of the organization.

Lean leadership attributes

Leadership, must ensure that all employees are completely engaged and participate in improvement activities on a daily basis.[24]

Thus, lean initiatives tend to fail when leaders are not able to seize and promote the need for systemic changes or organize their management based on the process rather than the outcome. Deploying lean thinking needs development of mentality in which employees are encouraged to make improvements.[25] In contrast with the sameness and consistency of manufacturing products, the implementation of lean to health care must be modified due to the high diversity of the "product", which is health, and applies to unique individuals with unique constellations of symptoms. The majority of current studies focus on the application of lean in an organization. Although leadership is acknowledged as a significant parameter, the specific qualities and attitudes of a successful lean leader in healthcare have been insufficiently described.[24]

Dombrowski and Mielke[24] suggested a conceptual model for an integrated lean leadership system. According to this model, which is not industry specific, there are five core principles of lean leadership: improvement culture, self-development, qualification, gemba, and hoshin kanri. All of these five components contribute to the core concept of the team as the main active unit of a lean system. More specifically, teams that deploy front-line workers aim to employ engagement and improvement of process.[1] Improvement culture encompasses all these attitudes and qualities that create a continuous striving for perfection. Although leaders seek to prevent failure, when failure does happen, it is perceived as an opportunity for improvement. Failures are explored for their root causes, to ensure that the same or a similar failure will not reoccur. Every single person in the organization (employees, management, board) are vital parts of an improvement procedure. Leaders coordinate the problem solving and process management of the team, whereas front-line workers enact the processes.

The importance of self-development is based on awareness that the transition to lean leadership requires new leadership qualifications. Some of these skills are innate, and some of them must be learned. Lean leaders must act as role models and use the necessary leadership attitudes and skills. Qualification of employees include fostering employee involvement and training, commonly in apprentice-style learning. Qualified employees are more prompt to contribute in ongoing improvement, problem solving, and other lean practices. This process should be guided by a mentor, so as to establish daily routines and maintain a sustainable continuous improvement culture. Consequently, both leaders and workers, need to be mentored by a sensei, who provides objective feedback and guidance.[1]

The fourth principle of Dombrowski & Mielke's lean leadership model, Gemba, requires that leaders go to the place where value is created. Gemba in Japanese means "real place" and, in lean terms, refers to the environment where value-adding processes take place. More specifically, gemba refers to the necessity for lean leaders to comprehend the situation on the front lines, and to realize the problems and processes that their employees encounter. Interestingly, regular gemba walks are also indicative of the leader's appreciation for the work of employees in creating that value. When a problem appears, lean leaders act according to five "golden gemba rules": go to gemba; check; take temporary countermeasures; find the root cause; and standardize. The ability to apply this algorithm constitutes a core leadership skill.

On the other hand, Hoshin kanri, which is also called "target management" or "policy deployment", is a strategy of lining up goals with customers. Hoshin kanri facilitates a system approach for improvement, by uniting all teams to collimate with the same strategic target. Even though each team has a unique short-term goal, Hoshin Kanri strengthens the combination of different teams in order to accomplish long-term goals. Consequently lean leaders must be able to design long-term strategies and goals based on the co-ordination of team-work.[1] For a more detailed analysis of the five principles of Dombrowski & Mielke's model the reader is referred to the study of Aij and Teunissen.[1]

Process

A successful care process requires commitment, involvement and continued support of leaders for the "front line" workers. Additionally, a consideration of relevant ideas suggested by these professionals is also vital. For instance, according to a study carried out in the emergency department, managers allowed the "front line" workers to detect issues in patient flow and propose their own solutions. The result was that this approach improved the care provided, ensuring that the team was more able to introduce new perspectives for problem resolution, instead of simply implementing guidelines imposed by managers. Lean thinking is based on the concept that doctors, nurses and other professionals working on the "front line" of health services are better positioned to indicate changes that are required for patients to have their needs met, therefore implementing good clinical practice.[26]

Another study from a UK centre specializing in cardiothoracic care highlighted the importance of managerial skills as essential principles for facilitating the implementation of lean in healthcare. In particular, open dialogue, inspiring people to approach old issues in modern ways, maintaining the

enthusiasm of colleagues, and developing actions for facilitating and enhancing communication were some of the most important skills.[27]

Another bright example derives from a study carried out in a hospital emergency room in Canada, where patients were treated for acute coronary syndrome. The basic concept was to reduce the time of medical interpretation of the electrocardiogram (ECG), medical evaluation, and administration of acetylsalicylic acid, using lean principles.[28] To achieve these objectives, specific modifications had to be done. These alterations included creating a dedicated ECG room next to the emergency triage, establishing nurse triage as the first point of contact for the patient in the department (instead of a secretary), relocation of equipment and materials in order to reduce movement of nurses and patients, institution of a procedure for immediate ECG interpretation by doctors, readjustment of tools for risk stratification by nurses, and finally, screening and clarification of the criteria for activating the flowchart for patients diagnosed with acute coronary syndrome. This study revealed that the application of lean mentality improved the performance of early diagnosis and treatment targets for emergency cardiac care in this particular service. Moreover, apart from improving patient care, lean management

facilitates the understanding of processes in order to recognize and analyze any potential issues together with the existing waste, create more effective and efficient processes, offer information for the problem solution in order to prevent health damage, by following scientific and evidence based approaches.[2] A wide spectrum of tools can be used in order to improve processes, including value-stream mapping, process mapping, standardization work, team-work, rapid improvement events, pull system etc.[2] All these tools enable the detection of waste and integrate stages for the most efficient and standardized processes.

Results from systematic reviews

Mazzocato et al.[12] reviewed 33 articles and found a wide spectrum of lean applications. The articles involved in this study describe initial implementation stages and emphasise technical aspects. Interestingly, all articles revealed positive results. The authors detected common contextual aspects that interact with various components of lean interventions and trigger four different change mechanisms: comprehension of processes to generate shared understanding; organization and design for efficiency and effectiveness; improvement of error detection to increase awareness and process reliability; and collaboration to systematically solve problems to enhance continual improvement. This study concluded that lean thinking has

been successfully applied in several healthcare settings. Although lean theory emphasizes the importance of a more holistic approach, the majority of cases report narrower technical applications with various limitations in terms of organizational reach. The authors suggest that in order to realise the potential benefits, it is vital to directly involve senior management, pursue value creation for patients and other customers, work across functional divides and nurture a long-term view of continual improvement.

Similarly, as described above, the integrative review conducted by Magalhães et al.[2] analyzed 47 articles. The categories were developed from the quality triad proposed by Donabedian: structure, process and outcome. Although lean thinking is on the rise in health services, especially in the USA and UK, by improving the structure, process and outcome of care and management actions, it is still an emerging theme in nursing. According to the results of this study, lean thinking has a transforming effect on healthcare and organizational aspects, promoting advantages in terms of quality, safety and efficiency of healthcare and nursing providing a patient-centered approach.

Moraros et al.[29] attempted to independently assess the effect of lean, or lean interventions, on worker and patient satisfaction, health and process outcomes, and financial costs. In this study, an overall of 22 articles passed their methodological quality review. Among these studies, 4 were exclusively concerned with health outcomes, 3 included both health and process outcomes and 15 included process outcomes. It was found that lean interventions have: (1) no statistically significant correlation with patient satisfaction and health outcomes; (2) a negative association with financial costs and worker satisfaction and (3) potential, yet inconsistent, benefits on process outcomes like patient flow and safety. Consequently, and in contrast with other studies, and while some strongly support that lean interventions lead to quality improvements in healthcare, the results of this study are contrary with this claim. This indicates that more rigorous, higher quality and better conducted scientific research is required to define the impact and effectiveness of lean in healthcare.

Researchers should use a valid protocol when it comes to a systematic review. Lawal et al.[30] developed a protocol for a systematic review, according to the Cochrane Effective Practice and Organisation of Care (EPOC) methodology. The target of their study was to record, categorize and synthesize the existing literature on the effects of lean implementation in healthcare settings, especially the potential effects on healthcare and professional practice outcomes. The authors developed a Medline keyword search strategy, to translate this focused strategy

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into other databases. Overall, a systematic review aims to identify, assess, and synthesize the evidence to underpin the implementation of lean activities in healthcare as defined by a study protocol. The study protocol developed by Lawal et al.[30] provides an evidence base for the effectiveness of lean and implementation methodologies reported in healthcare.

Improving the application of lean in healthcare

Tools and methods are vital at the setting Toyota, but developing a "routinized learning capability" based on stable practices for problem identification, problem solving and solution retention is even more important.[31] Most organisations restrict themselves to adopting specific lean principles for problem solving within one specific unit or department. However, Toyota has realized that given a state of continuous change and flux, the best expectation that someone can have is developing countermeasures that will only *"serve until a better approach is found or conditions change"*.[32]

In order to improve the effectiveness of lean thinking in healthcare, organizations should:

- Implement strategies and methods that lead to relay information to problem solvers and create solid structures for constant improvement. Subsequently, standards and learning

can be improved, whereas positive outcomes can be sustained.

- Engage management in continual problem solving. In contrast to the large fraction of time Toyota leaders and managers spend on problem solving,[31] only a small number of papers referred to management involvement in rapid problem investigations. More specifically, letting staff enthusiastically detect and solve problems on their own, as some propose, is contrary to Toyota's mentality and approach to lean, and is disinclined in other healthcare studies. As a matter of fact, management often misinterprets their role in lean implementation. On the contrary, part of the challenge lies in supporting senior management reject quick fixes in favor of addressing root causes with a long-term philosophy.[33]

- Embrace a more holistic approach and connect to the larger context.[12]

Team climate for innovation as a context factor

Comprehending group processes and performance requires thorough consideration of the group's organizational context. Referring to Organizational Health Interventions (OHIs), context is defined as the underlying frame affecting the

implementation and the effects of the intervention.[34] The concept of team climate includes shared perceptions of organizational procedures, practices and policies, and refers to a group of professionals that interact on a regular basis in order to accomplish work-related tasks. In other words, it can be considered as a context-related factor since it refers to the immediate social milieu in which people create reality to formulate and express perceptions, attitudes and behaviors .[34] Team climate inventory (TCI) consists of a team-level concept of how far a team's values and norms emphasize innovation.[34] In order to create an innovative team climate, 4 parameters have been found to be critical:

1. Vision as clearly defined and valued group goals
2. Participatory decision-making
3. Task orientation
4. Support for innovation

The TCI has been validated in several studies worldwide[34] and has often been applied in the healthcare. There is evidence that the utility of the TCI has been empirically demonstrated as a way of examining and predicting healthcare teams' innovativeness.[35] For example, a study from a hospital in Australia showed that team work effectiveness (measured with the TCI) was substantially correlated to the effective use of an innovative online evidence system for clinical care.[35] Moreover, teams with clear and shared objectives that focused on tasks with high quality, who were involved in decision-making and were keen to innovate, could work more effectively. Apart from that, they declared to be more satisfied at their workplace.[36]

Goal pursuit, setting and striving

Goal pursuit is divided into a goal setting and a goal striving phase. In general, goal setting refers to motivational processes, whereas groups need to set goals, as they need to define a desired end state in order to perform efficiently. Consequently, action planning toward a goal has a motivational effect and function. The majority of goal setting theories[37] have typically focused on creating goal intentions that are formulated by an expectancy-value paradigm[38]. Therefore, the expectations of people explain what kind of goals they tend to choose. People are expected to commit to goals in which attainment is both feasible and highly desirable. Feasibility includes the beliefs that future actions will be eventually realized. On the other hand, desirability is perceived as expectations about the pleasantness of the effects of goal attainment.[38] After the assessment of the desirability and feasibility of an outcome, people commit toward a goal if they believe that the expected outcome value is adequately high. Regarding the significance of an expected value, outcome expectancies can be

considered as a goal-setting indicator, if perceived as beliefs about the consequences of somebody's individual actions.

Outcome expectancies are significant because people are guided and motivated by the perception that their respective actions (over a prolonged period) will lead to positive outcomes. This phenomenon derives from the fact that successful outcomes motivate professionals to put more effort into their goals, even when obstacles or other difficulties arise. Moreover, outcome expectancies are "contagious" which means that enthusiasm can be transmitted within members of the same team, even to those who were not initially involved in the goal-setting procedures.[39]

Furthermore, outcome expectancy is expected to be stronger among groups rather than among individuals as it refers to the belief that the collective agency will produce the desired effects. The consistency of collective expectations indicates an emergent and solid capacity that is more likely than individual efforts to make alterations possible.[40]

Although goal setting encompasses substantial motivational parameters for goal pursuit, it may not always be sufficient to achieve a goal. Goal striving refers to the behavior toward the desired end state. Individuals tend to realize their intentions by adding goal intentions with volitional components (e.g. plans). Supporting goals

with self-regulatory planning is called "implementation intentions". These strategies specify when, where and how action should occur to reach an intended goal. These are the so-called "if-then plans", which define a critical cue or condition x ("if") and pair it with a goal-directed behavioral response y ("then").[2] In that case, the underlying psychological mechanism is associated with the consignment of goal-directed behaviors to environmental stimuli and form a mental representation of the situation leading to an automatic action control.[41] There is a significant amount of empirical evidence highlighting the powerful effects of implementation intentions for various types of goals. A meta-analysis illustrated medium-to-large effect sizes of the implementation of intentions to achieve goals in comparison with the goal intention only.[41] Although the majority of similar studies were conducted at the individual level and/or in a laboratory setting, there is emerging research on the impact of collective implementation intentions that can also be applied to an organizational setting. "We-plans" that define when, where and how a group behaves toward a collective goal should afterwards support collective goal striving that improves performance and probably act as an expedient strategy for reaching goals within OHIs. Considering OHI research, the significance of the formulation of action plans (including

aims, specific activities, resources and deadlines) has also been discussed.[42] Overall, it appears that specific contents can contribute to specific intervention mechanisms, meaning that action plans formulated as "if-then" plans illustrate a volitional goal striving indicator that is independent of the content itself.

Structure

Considering the physical structure of the places where care is delivered, studies were implemented in a wide variety of departments and units, including:

- Chemotherapy
- Cardiology
- Hospital pharmacy
- Emergency department
- Intensive care
- Surgical centers

By using lean approach, communication among members of the multidisciplinary team were eased, increasing efficiency and streamlining. As for reducing bureaucracy and facilitating healthcare, it is suggested that normative, technical and administrative instruments, lean thinking guides be standardized, and care processes should be simplified. These alterations reduce ambiguity at work, creating a more continuous flow of care, and allow professionals to work more independently in the execution of activities and problem solving.[43] According to a study

conducted in a surgical centre, a standardized description of the procedures carried out by the surgeons enabled the team to estimate more accurately the duration of each procedure.[44] Consequently planning for the use of operating rooms became simpler and faster, contributing to improved management of opening and closing the rooms within each specialty. Additionally, the ability to plan surgical schedules more precisely, avoids waste with poorly and/or incomplete distributed schedules. Lean thinking provides economic upturns and positive impacts on the financial income of healthcare organizations, either by reducing the financial costs or by increasing the capacity for patient care. Optimization of the operating room capacity by using lean management at a hospital in Luxembourg, led to an increase at the number of surgeries per year without any alterations in the quantity of personnel. This required training and motivation of the staff, which had repercussions on eliminating unnecessary waiting periods and stress prior to surgery and increased the transfer rate of patients in the operating room to other units.[45]

It has been suggested that the ideal professional to conduct a lean modification in a hospital is the nurse because he or she has adequate experience in leading multidisciplinary teams with commitment to patient care and a better understanding of patient's perspective.[46] However, nursing

education needs to be reviewed and the curriculum should include concepts, tools, and skills necessary to incorporate lean to the patient care environment. Organizational development, lean principles, quality improvement, inventory management, consulting process, value chain management, analysis queues, diffusion of innovation, complexity science and negotiation must be incorporated into nursing curricula to help new nurses adjust to the lean work in health institutions.[46]

Discussion and practice implications

The success of lean thinking in healthcare derives from its ability to organize a complex intervention process that incorporates and integrates several variations of 4 categories/types of components, which are the following:[12]

1. Methods to understand processes in order to identify and analyze problems
2. Methods to organize more effective and/or efficient processes
3. Methods to improve error detection, relay information to problem solvers, and prevent errors from causing harm
4. Methods to manage change and solve problems with a scientific approach.

Developing a shared understanding among different professionals about healthcare as a process enables staff to develop a collaboration and design in more effective

manner, establishing efficient and stable processes and making deviations easier to detect and counteract. This mentality has a vital impact on work practice and culture, allowing further improvement. These improvements can be enhanced via training, education and solid structures for continual improvement which resonate with the macro, meso and micro systems' vision, and through consistent demonstrations by management that improvement is everyone's responsibility. The 4 mechanisms, mentioned above, impact and change the context suggesting that 'lean' is an evolutionary process that happens over the course of time and not just a matter of incorporating the four components in practice; something that echoes results from previous research on introduction of improvement strategies in healthcare.[47] To reflect this, Toyota managed to develop lean over decades as a strong response to organizational, managerial, political, and competitive alterations and challenges.[31]

Prior to initiating lean hospital management or proceeding with the next stage, it is suggested to analyze thoroughly the current situation of a hospital and assess the suitability of planned lean activities. This should consider that knowledge, optimization goals, project timing, methods and accompanying change in management can be

tailored to the specific requirement of a hospital.

Apart from reducing waste and achieving sustainable results, lean strategies can reduce job-related burnout. A study by Hung et al.[48] evaluated the degree of burnout and how health professionals perceive their daily work activities by measuring:

1. Emotional exhaustion or fatigue from delivering patient care

2. Depersonalization, a hardening of the attitudes of care providers toward patients

3. Personal accomplishment, a positive self-assessment of care provision

The application of a quality improvement system that has been proven to work efficiently in high volume/low variety industrial organizations such as manufacturing, to the low volume/high variety in demand environment of healthcare, has been initially faced with skepticism. In comparison with other fields of interest, healthcare is more complex, and therefore lean concepts have not penetrated all its aspects in healthcare organizations.[49] Several studies have investigated factors for the successful implementation of lean emphasizing the benefits of the project to the organization. Organizational readiness is a prerequisite for initiating and implementing lean projects. Successful implementation of

lean calls for special attention to factors including strong leadership, training and stakeholder involvement, the basic stability of the organization, the ability to connect lean with strategy and establishing a measurement and reward system linked to lean goals.[49]

Theoretically, a systematic application of lean is expected to achieve better results. As doctors have a strong tradition in evidence-based care, they are usually willing to accept modifications that are based on solid evidence. Subsequently, although single project implementation can provide a quick effect and promote the application in the whole system, its effect is limited if compared with the systematic application. Thus, partial application should not be considered as a limitation, but as an inevitable path for the promotion of lean thinking in the healthcare.

Conclusion

The implementation of lean principles and tools in healthcare has gradually led to a significant improvement in quality and efficiency. However, the transition to lean requires a substantial investment of time. Subsequently, the sense of urgency in the improvement of management in healthcare systems is more recent in comparison with world class manufacturers whose staff had a long exposure to the need for modifications, and had to adapt in order to remain competitive. The increasing interest on

efficiency gains has led to several partial implementations of lean, due to the fact that managers have tried to reiterate the successful implementations similarly to other organizations but without comprehending the underlying principles of lean. A deeper understanding of lean, together with a more detailed research and reporting, can contribute in preventing mistakes and increasing successful lean implementations in healthcare. Lean consists of a hands-on improvement approach, compatible with suggestions made by leading authors on how to improve health care organizations.

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ANNEX

TABLE 1. Most common wasteful activities

Overproduction	Excess, premature, or faster production of a product that exceeds the demands of the next level of production
Inventory	Apart from consumption follow-up and space required to store, there is a need to follow expiration dates and to constantly ensure that the items in the inventory are not technologically obsolete. The overall cost of smaller and more frequent supply inventory is lower than a large-volume purchase for which a discount is provided.
Motion	Poor motion is usually correlated with poor design of the working area
Transportation	Problems of transportation in healthcare can be evident when moving patients, lab tests, information, etc.
Over-processing	When material provided to the customers (patients) mandated by regulations can be confusing (e.g. multiple insurance claim forms).
Defects	Defects can be associated with poor labeling of tests, incomplete information in patients' charts or insufficient instructions provided in referrals, etc.
Waiting	Unnecessary queues and waiting for materials, resources and services; opposite to 'just-in-time' supply
Under-utilizing staff	This parameter is time-dependent, and multilayered. It typically shows in hierarchical structures and poorly coordinated teamwork. Characteristic examples: Not sharing knowledge or poor utilization of someone's skills and creativity.

TABLE 2. Lean principles

Value	*Provide the value customers actually desire* - Defined according to customer's view and waste identification.
Value stream map	*Identify the value stream and eliminate waste* 1) Product/service definition – from its concept, detailed planning and launch; 2) Information management – from order taking, detailed scheduling to delivery; 3) Physical transformation – from initial concept to product delivery to consumer.
Flow	*Line up the remaining steps to create continuous flow* - Removal of large obstructions and reformulation of process, introducing new types of organizations and technologies, eliminating interruption, detours, backflows or waiting.
Pull	Pull production based on customers' consumption - The customer is allowed to pull the service and it results in prevention of waste, such as production of obsolete or undesired goods, elaboration of unnecessary inventory tracking system and overproduction.
Perfection	Start over in a pursuit of perfection, 'the happy situation of perfect value provided with zero waste' - Continuous and systematical root causes removal of waste to achieve the ultimate goal of zero defects, minor time, steps and waste.