Implementing continuous improvement in healthcare: a case study of lean application in an emerging country hospital

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Abstract

Brazil is a geographically large country with widespread regional and social inequalities. Its Unified Health System is challenged by problems due to the size of the country, poor management of resources, and insufficient funding. As the Lean approach has been successfully implemented in healthcare as a tool for process improvement, this study focuses on the investigation of the applying Lean concepts in Brazilian hospitals. A case study developed in a non-profit hospital in São Paulo state, suggests that it is feasible to apply lean techniques to achieve process improvements and cost savings for hospitals in emerging countries.

Keywords: Lean healthcare; Quality improvement; Hospital management.

Introduction

Brazil is a large country of continental dimensions with a population of more than 200 million inhabitants and widespread regional and social inequalities (Paim et al., 2011)

(IBGE, 2017). Despite its many problems, Brazil's public health system has brought healthcare to millions of its poorer inhabitants who were previously denied even basic care (WHO, 2017). The Unified Health System (SUS – *Sistema Unificado de Saúde*) was founded by the 1988 Constitution and is based upon the principles of health as a citizen's right and the state's duty (WHO, 2017;Paim et al., 2011). According to the Brazilian Ministry of Health about 70% of the Brazilian population depends exclusively on SUS (Brazilian Ministry of Health, 2017). As reported by the Brazilian Federation of Hospitals, approximately 4,810 hospitals participate in the SUS, of which 807 are private, 1,665 are non-profit and 2,338 are public (Brazilian Hospitals Federation, 2017). Many in the last two categories are in a precarious situation regarding infrastructural and technological maintenance, supplier provisions and personnel training. This situation is due in many respects, to poor management of resources and insufficient funding leading to the lack of beds that are adequately equipped to provide medical care to everyone who needs it. All this constitutes an absolute recipe of chaos lived by almost all the healthcare units in the public network (Ferraz, 2008).

In recent years, the Lean approach has increased in popularity as a tool for process improvement in developing and emerging countries and is one of the most commonly used in the health sector (Aguilar-Escobar et al., 2015; Mazzocato et al., 2016; Honda et al.,2018).

The Toyota Production System first appeared in Japan after the Second World War. At that time the country had to restructure itself and did not have the resources to do mass production. The creator of the Toyota Production System was the executive head of the corporation, the engineer Taiichi Ohno and the disseminators were the founder and master of inventions, Toyoda Sakichi and his son, Toyoda Kiichiro. Its principles are based on reducing waste, improving product quality and reducing customer delivery time. It was from this concept of producing more with less and less that the system came to be called Lean Manufacturing by James P. Womack and Daniel T. Jones in their book *The Machine that Changed the World*(Womack et al., 1990).

Lean Healthcare refers to the application of Lean philosophy and principles in a healthcare environment. Basically, it is about understanding what is valuable to the patient in order to distinguish activities that add value from those that do not. Activities that do not add value are called waste and should be avoided or removed (Filser et al., 2017). The principles of Lean Healthcare are listed in Table 1.

Table 1: Principles of Lean Healthcare

a) respect and commitment of all with the reduction of waste;
b) 5S and visual control (5S represents Japanese words that describe the steps of a workplace organization process: Seiri (Sort), Seiton (Straighten, Set), Seiso (Shine, Sweep), Seiketsu (Standardize), Shitsuke (Sustain))
c) "just in time" (correct service, in the right amount, at the right time and in the right place)
d) level workload and standardization of activities (balancing the distribution of activities and optimize the work itself)
e) continuous flow (the use of pull systems allows much less wasteful process and flows)
f) "built in quality" (make problems visible, never allow a defect to last to the next level, make an error-proof system, interrupt when there is a quality failure)

Source: Adapted from Robinson S, Kirsch J. Lean Strategies in the Operating Room. Anesthesiology Clinics. 2015;33(4):713-730 (Robinson and Kirsch, 2015)

Although the literature demonstrates that Lean is widely recognized in healthcare delivery circles and have been increasingly used in healthcare sector (Young and McClean, 2009), most of publications comes from developed countries and hospitals with significant resources. The United States of America and the United Kingdom lead the publication ranking on this matter, followed by the Netherlands and Switzerland (Costa et al., 2015; Moraros et al., 2016). There are a few studies conducted in developing and emerging countries, specifically India and Brazil, some of them are shown in Table 2.

Table 2: Published studies on Lean Healthcare from developing countries

Author	Title	Country	Findings
Gijo and Antony (2013)	Reducing Patient Waiting Time in Outpatient Department Using Lean Six Sigma Methodology.	India	The average waiting time reduced from 57 min to 24.5 min and the standard deviation was reduced to 9.27 from 31.15 min.
Miller and Chalapati (2015)	Utilizing lean tools to improve value and reduce outpatient wait times in an Indian hospital.	India	The average waiting time reduced from >1 hour to 15 minutes, the number of patients per day increased from 40 to 120, the number of patients staying overnight decreased from >10 to <1.
Costa et al. (2015)	Lean healthcare in developing countries: evidence from Brazilian hospitals.	Brazil	a) Sterile Processing Department: cost (78%) and delay (94%) reduction; b) Pharmacy: balance inventory reduction; c) Chemotherapy: 33% increase in monthly revenues; 42% reduction in average patient lead time; 6% increase in the sector capacity; d) Operating Room: increase in monthly revenue; in the number of monthly surgical admissions; and in the number of monthly surgeries.
Bhat et al. (2017)	Productivity and performance improvement in the medical records department of a hospital: An application of Lean Six Sigma.	India	The turn-around-time was reduced from average 19 minutes to eight minutes and the standard deviation was reduced by one-tenth.

Source: the authors

Since the current literature presents success stories in developing and emerging countries, which consist mostly of elite hospitals that serve a small part of the world population, this study focuses on finding evidences of the feasibility in applying Lean techniques to achieve process improvements and cost savings in the hospitals in developing and emerging countries.

Methods

The case study was the chosen method for this research. It consists of an empirical approachto investigate atopic according to a pre-specified set of procedures (Yin, 2009). This study presents a description of the implementation of continuous improvement techniques in two strategic processes in hospital management.

The setting for this research effort was a Brazilian 300-bed non-profit hospital located in São Paulo state. It serves about 700,000 people, including the 350,000 inhabitants of its own city and others from the region. About 90% of its beds are reserved for SUS patients. This hospital is a typical representative of the majority of Brazilian hospitals as well as healthcare institutions of other developing and emerging countries. Despite all the financial issues, the hospital is still investing in management innovation using a consulting firm to implement quality improvement techniques to enhance management processes.

The hospital's two processes studied in this case were the "purchase and stocking" and "prescription, pharmacy dispensing and medicines administration." Each one of the intervention projects has its specific interdisciplinary team consisting of a manager/leader (i.e., clinical nurse, pharmacist or purchaser), the respective department's staff and external consultants. Additionally, the information technology staff, analysts and the continuous improvement team participated in the project at key stages. All projects were implemented following the DMAIC methodology.

DMAIC is a continuous improvement process with five steps: Define, Measure, Analyze, Improve and Control. In the "define" phase, the project focus is established as well as the study object and the problem we want to eliminate. In the "measure" phase, management teams collect data to estimate the process capability to meet the customer demands and provide information to the analysis process under study. In the "analyze" phase the main causes of the problems are identified, organized and validated. The "improve" phase is where the team proposes, plans and implements the solution. Finally, the "control" phase ensures that the achieved improvements are sustained and will not be lost (Carpinetti, 2016; Boon Sin, 2015).

The research questions were formulated according to an implementation framework. The implementation variables chosen for the case study, which originated the questions, were based on a literature review of practical cases and specifically on the case study protocol presented in one of these studies (Costa et al., 2015). The variables and steps of this case study are presented in Table 3:

Table 3: Variables and data sources of this case study

CASE STUDY PROTOCOL			
OBJECTIVE			
Study lean healthcare application in a non-profit hospital			
RESEARCH QUESTION			
Is lean feasible to apply and to achieve process improvements and cost savings for hospital in emerging and developing countries?			
What are the quantitative and qualitative results obtained from implementing lean healthcare?			
VARIABLES STUDIED			
a) Departments involved		e) Training provided	
b) Improvement implementation period		f) Tools employed	
c) Benefits obtained (quantitative/qualitative)		g) Barriers to the improvement implementation	
d) Composition of interdisciplinary teams		h) Critical factors of success	
	DATA SOURCES		
	Primary		Secondary
	A) Interviews with departments staffs and consultants	**B) Direct observation of**	**C) Analysis of**

	A1)Department Staff	A2) Consulting firm member	**the processes in the involved departments**	**documents provided by the teams and consulting firms**
General Information	Two people from the pharmacy answered this questionnaire, one of them was the leader of the project. In the purchasing sector the project leader answered the questions but it was not possible to talk personally with any person from the nursing team during the visit due to the nurses' rather rushed routine. The interviews were scheduled by phone and conducted during the visits.	The owner and also member of the two projects studied. The interviews were made by conferences and scheduled by e-mail	During the visit the responsible person for the pharmacy and the person in charge of the sector of purchases presented their respective departments and it was possible to follow closely the operation of both systems. The talks were recorded for reference and for further information	The consulting firm and the hospital quality team provided a database of the project material with spreadsheets and charts. The website of the hospital and the database and the National Registry of Health Establishments - CNES were also consulted for further information.
Quantity	One with each person and posterior phone calls to resolve remaining issues	2 conference calls	2 visits	several documents
Duration	2h	2h	6h each	4h

INTERVIEW QUESTIONS	
A1) Internal members	**A2) External member (from consulting firm)**
What is your technical background?	In which processes were improvement projects carried out?
What was your role in the project?	What were the quantitative and qualitative gains?
When you first heard about the project, did you agree that this was necessary for hospital improvement?	How long did each project last? (the first full DMAIC cycle)
Have you ever had previous contact with any continuous improvement tool? Had you heard of it before	How many and who were the members of the team? What were the roles of each one?
Was the training enough to deal with the tools?	Did you give any training to the team? What was covered in this training?
At some point during the implementation, did you disagree? Has your opinion changed during the process?	Which tools were used in each step?
Did you have difficulty undergoing any changes during implementation?	What were the barriers / difficulties encountered before / during / after the project?
Is there anything you wanted to do that was not accepted? What was the idea or suggestion? What was the reason it was not accepted?	Which factors were critical to the success of the project?

Source: the authors

Purchase and stocking

This sector is responsible for guaranteeing the support and resources to offer qualified medical assistance, carry out purchasing and its storage management. The purchase manager monitors medicines and material quantities within a specified time. Before the implementation the purchase process used to take around 20 days, the stock was dimensioned to last 40 days. The storage was made in several locations resulting in excess displacement and space, which means there was also a waste of time and money.

Prescription, pharmacy dispensing and medicines administration

The routine prior to the project implementation was basically the physician manually wrote a prescription valid for twenty-four hours that had to be filled by ten o'clock in the morning, with a tolerance of two hours so that there would be a guarantee that all the remedies would be distributed in the afternoon after 12:00 noon. All the cumulative prescriptions were taken by a nurse to the pharmacy where the employees separated and packed the medications. These packages were sent in a single batch to the nursing station and administered according to the prescriptions by the nurses during the whole 24-hour period.

This system presented numerous failures, such as (a) the high lead time of the process, (b) the high percentage of returned medicines (c) the consequence of illegibility of handwriting or (d) the discharge, transference or eventually the death of the patient during the period. Another recurring problem of the pharmacy was the mistakes in the patients' billing. The major problem was in the case of medicinal products contained in vials for shared use. These are used in small doses by more than one patient, since the portion used was not computed, but the whole bottle was charged to the first patient.

Results

Purchase and stocking

The team was composed of a leader with technical training in logistics and operations background, warehouse employees, members of information technology, pharmacy, purchasing sector and two external consultants. The team members had training based on the principles of lean healthcare, inventory lot sizing, and a pull system (*kanban*). The weekly dedication of each of the internal staff was about three hours a week and a full day for the external consulting members. The project lasted about four months and after it the purchase process was reduced from 20 to 5 days, as shown in Figure 1:

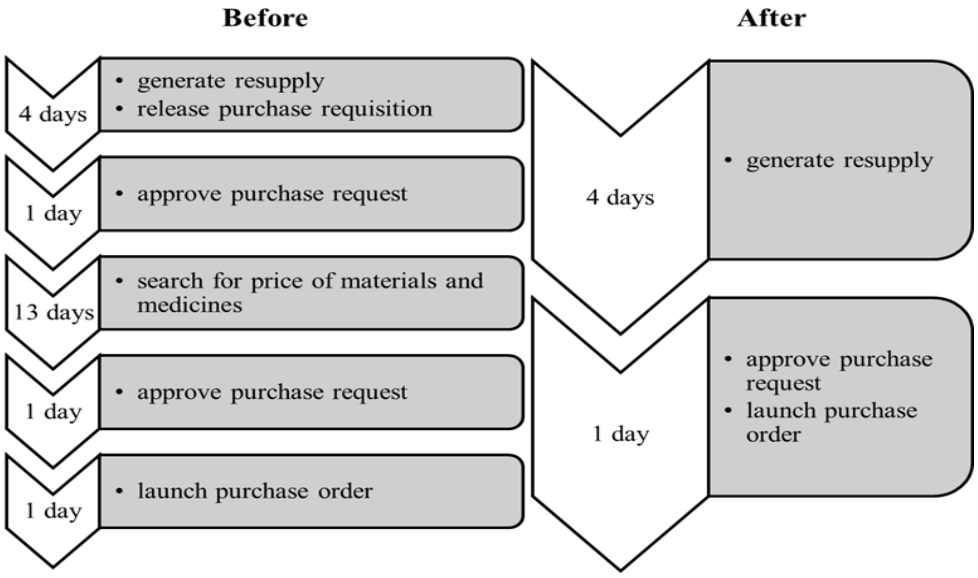

Figure 1: Time spent in each phase of purchasing process, before and after the intervention. Source: the authors.

The whole process has been redesigned and two major actions were fulfilled. First, it was found that some items are very expensive (e.g. antineoplastics), some are more frequently utilized and that suppliers would be willing to negotiate their prices. Then it was proposed purchases to be made more frequently, in order to win supplier loyalty and

combine long term prices. Besides the antineoplastics the other contemplated items in this new plan were: laboratory/radiology materials, surgical thread, enteral/parenteral nutrition, intra-venous (IV) solutions, cleaning material, among others.

A new system which was called “Scheduled Purchase” was adopted. One advantage of the "Scheduled Purchase" was the release of the monthly needs assessment with the entire quotation procedure, waiting for the response time and closing the order. The deliveries started to be weekly, via a pull system, that is, through order point. Due to the loyalty process of the suppliers and their fixed price contracts, the quotation and approval phases were eliminated from the process, making it more agile. So it was therefore easier to control the inventory and the stock became more current and smaller. It was also noticed that there was significance space that was freed up allowing the centralization of the material in one place.

Quantitatively, after just two months of “Scheduled Purchase” implementation there was a 22% stock reduction. As an example, in the case of the antineoplastic stock there was a 46% reduction, equivalent to approximately R$ 180,000.00 (Brazilian *Reais* or about US$ 45,000.00). A few months after, a greater number of materials were also included on the “Scheduled Purchase” list, resulting in a stock reduction from about R$ 2,400,000.00 (US$ 600,000.00) to R$ 800,000.00 (US$ 200,00.00).

Over time, due to the decrease of stock and freeing up of storage space, a new activity was included to the warehouse tasks: the organization and setting of different kits (e.g.; curative kit, probing kit, nursing procedures kit). These kits weren’t used previously, and the nursing staff had to leave their wards and go through various places to get the necessary supplies to assemble the kits. The implementation of kits also reduced the access time to the materials needed to perform common procedures and standards. The kits have daily replacement based on a report printed in the morning regarding the amount of kits withdrawn the day before. This measurement is performed through a barcode reader which is part of the hospital's software system. The importance of this control is reinforced by the slogan "*Se bipar não vai faltar*", which means that if the materials are passed in the bar code reader then there will be no shortage of them. Besides, kits undergo periodic evaluations to verify that items and quantities are meeting the needs of the procedures. Some items such as gloves, which have size S, M and L are loose in stock and are not included in the kits. In addition, a constant analysis is performed that results in the creation of new kits and improvement of those that already exist.

It is important to emphasize that the staff of the warehouse never had any problems that the kits were assembled by them and in their space, because there is a mentality that has been strongly reinforced that they are the support sector and the focus of nursing staff should be the patients’ care.

Prescription, pharmacy dispensing and medicines administration

The project team was led by the responsible pharmacist. It consisted of two members of the pharmacy improvement team, the nursing manager, three external consultants and two analysts. All internal members received training in Lean Healthcare, process mapping, flow, process balancing, 5S, work standardization and visual management. The members of the pharmacy team had partial dedication to the project, as they worked on implementation around four hours per week. The consultants and the improvement team spent a slightly higher average, around six hours a week, on the project. The total duration of the project was three months.

The team identified that the main problems were delay and error in prescriptions and deliveries, so they established the following goals:

- Deploy 100% electronic prescription replacing the manual prescription;

- Reduce by 30% the total lead time of the medical prescription (9,5 hours), that is, to optimize the time of the path of the prescription that begins with the physician, is taken to the pharmacy, then sent to the hospital ward and applied to the patient;
- Reduce 90% of the divergences and errors in medical prescription;
- Reduce unnecessary movement of nursing between wards and pharmacy;
- Improve consumption control in the patient's bill.

The next step was to define the root causes of the problems: Many prescription errors were attributable to manual writing, which does not have a fault-control mechanism or much less, guarantee readability. Errors and delays in the delivery of medicines occurred for several reasons. For example, non-adherence to the prescription limitation rule, dispensing errors of the pharmacy, the disregard for processes (lack of protocols), a disorganized work environment, poorly sized stocks and imbalance of resources in relation to *takt*-time, that is the amount of time in which a product needs to be provided in order to satisfy consumer demand.

The improvements occurred from a kaizen event in which the following changes were implemented:

- A new schedule was developed for receipt of prescriptions and delivery of medicines and was implemented. With this new approach, the day was divided into three shifts to receive the prescriptions, delivering the medications and their application;
- Electronic prescription: the physician writes the prescription in a computer and it is printed directly at the pharmacy;
- Drug application kit on package: prior to implementation, application kits were kept in the nursing station. After the implementation they were placed inside the package along with the medicines (this decreased the number of tasks performed by the nurses);
- Re-design of the layout of the Central Pharmacy (via 5S);
- Storage area for IV solutions and medicines outside the pharmacy: the sera took up a lot of space, so they were relocated.

The time the prescription takes to reach the pharmacy was reduced from 3.5 hours to a few seconds, the lead time was reduced from 9,5 hours to 5. The results were very satisfactory, there was also a reduction in prescription errors, delays, inventory and patients' waiting times. Before the implementation the nurses were required to carry prescriptions to the pharmacy, seek resources through various places such as IV solutions or pain/fever killers. A movement measurement revealed that the average move was almost four kilometers and the nurses spent a lot of time shifting and doing non-value added activities. Actually, the average move covered by each nurse is now one kilometer and a half resulting in a 63% reduction.

With respect to the kits assembled in the warehouse, the most common materials used for drugs administration are now supplied in the form of kits by the pharmacy. Every time these materials are taken from the station they are screened at the bar code reader by the nurse. This action promotes a replacement request to the pharmacy. The most common materials and medicines used in patients care, such as non-sterile procedure gloves, bandages and syringes, are now computerized in each patient's bill according to the average usage.

Discussion

Although the projects were planned and executed separately for each sector, it was possible to see that the improvements were not restricted to the area in which they were implemented. The changes in the pharmacy and purchasing sectors had a direct influence on the nurses' work. By improving the processes which are linked to the nurses' work it

becomes possible for them to be more efficient in their critical daily tasks allowing them more time for other essential nursing duties (Kieran et al., 2017).

One of the difficulties was the fear and distrust on the part of the employees at the beginning of the projects. There was some disbelief about the veracity of the numbers and the new system proposed to them. As the results came (quick wins) throughout the work, the team gained confidence.

The manual writing of prescriptions is one of the recurring problems in the pharmacy. In some cases, the physician wants to add some medicine or make some change to the first version of the prescription. To accomplish this, the physician should follow the same procedure as with the initial prescription, that is, prescribe electronically, so that the change reaches the printer directly at the pharmacy. However, what often happens is that some physicians still add in handwritten information to the printed version that is at the nursing station. This creates a break in the information flow and causing an unnecessary increase in work to the nurses who need to deliver the new prescription to the pharmacy.

Conclusion

Lean healthcare has been widely used in the quest for excellence in quality and maintenance of the competitiveness of large hospitals mostly in developed countries. There are limitations of this study, such as the lack of statistical evidence. Higher quality and a better scientific research approach is required in order to more accurately determine the impact and effectiveness of Lean in healthcare settings (Moraros et al., 2016). With this case study it was possible to conclude that Lean Healthcare can bring potential benefits where it is applied, even in non-profit hospitals of developing and emerging countries, where often the lack of resources hinders management's ability to make improvements. Nevertheless, the studied institution obtained considerable cost savings and process improvements, thus confirming the feasibility of applying Lean techniques and achieving process improvements and cost savings for hospitals in developing and emerging countries.

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