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# Lean Healthcare Applied Systematically In The Basic Image Examination Process In A Medium-sized Medical Clinic

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**Abstract.** The objective of this paper is to propose a systematic application of Lean Healthcare in the activity of fetching the next patient in the X-ray examination process. The methodology used is based on two pillars: the first, called a survey, aims to map the process in which the focus activity is inserted and, thus, obtain the associated waste, identifying the root cause of what will be treated. Then, the proposed Lean pillar will propose a tool to remedy the waste in question, applying the necessary actions within a schedule and, finally, collecting the results and comparing them with the initial measurement. As a result, there is an improvement in the hospital processes from the Lean perspective, specifically in the activity of fetching the next patient, in the X-Ray examination, reducing the non-added value identified in this activity, that is, in the waiting time of the patient. As conclusions, it was possible to obtain concrete information about the implementation of this proposed systematic application, so that it can be replicated in other wastes, generating a systematic proposal, filling a gap in the literature, which covers the lack of fully structured studies with practical results of Lean Healthcare systematics in the medical clinic wing of hospitals.

**Keywords:** Lean Healthcare, Health Services, Medical Clinic, X-ray exam.

## 1 Introduction

Given the development of the Toyota Production System (TPS), [1] stated that the production of small quantities with a variety of products was appropriate for the reality in Japan. As such ideals went against Mass Production, TPS focused on increasing

efficiency with the methodical and complete elimination of waste. Thus, this system, later named Lean Manufacturing or Lean Production, was inserted in the means of manufacturing based basically on waste reduction, through the elimination or mitigation of non-added value [2]. Lean Production established a production method that, at the same time, prioritized the elimination of waste without neglecting the quality of the resulting product at the end of the process, ensuring cost reduction for the organization and the approval of its consumer market.

In addition, over time, Lean Manufacturing has become part of other realities on the market, such as the service sector, creating the concept known as Lean Management [3]. Thus, the Lean tool can be used in several areas of production, service provision or decision making, given that there is a plausible conduct of its application. Therefore, it was reflected in the health environment, with the designation of Lean Healthcare. Managers and politicians have struggled to limit rising costs, while still providing appropriated health care [4]. Hospital's environment is very conducive to incorporating Lean, given that such health organizations are complex places of great social importance, which must provide quality services with a comprehensive restriction of resources [5]. Hospital environments in Brazil operate with a budget that is often less than necessary [6], so you have to be even more competent in your processes to be able to serve your patients without reducing the expected quality, after all this issue directly affects the health, well-being and even the life of your patient. Many healthcare organizations have improved their operations by adopting the lean healthcare approach [7-9].

With the increasing application of Lean Healthcare in recent years [10] the research problem is configured to use, appropriately, the teachings and tools derived from Lean to achieve a standard of application that can be replicated in hospitals in the future. So, the objective of this paper is to propose a systematic application of Lean Healthcare in the activity of fetching the next patient in the X-ray examination process, with the specific objectives of: (i) surveying the current state of the X-ray examination in patients in the medical clinic wing, (ii) use the tools and concepts available in the literature to support the solution of the identified wastes and (iii) propose a viable solution aligned with Lean Healthcare and collect its results.

The justification for this study is given by the benefits that Lean Healthcare is able to bring to health services, focusing primarily on hospitals within the Unified Health System in Brazil, especially in the medical clinic wing, as well as the importance of the study hospital to its region.

It is important to highlight that, notoriously, other papers have already addressed individual applications of Lean Manufacturing in health sectors, however this study is part of a project branch, based on the non-identification of applications in the medical clinic wing of hospitals [11], in order to formalize a systematic application of Lean Healthcare in this wing, through the application proposed in different activities e.g. [12-13].

Finally, some studies also bring systemic applications of Lean Healthcare [14], however they point out that it was not fully applied and the associated performance measures were not elaborated. So, the proposed application is a novelty justified, given this gap, through the complete application of a new proposed systematic, collecting the results of the application, for future replications, especially in the medical clinic wing.

## **2 Theoretical Reference**

### **2.1 Lean Healthcare**

Lean manufacturing is primarily based on the elimination of waste, assisting the process of value creation for all stakeholders [15]. In hospitals, the main processes are those responsible for the diagnosis, treatment and convalescence of the patient. The other processes are supporters of the essential services [16-17]. For [18] the application of the Lean philosophy in health is perfectly acceptable, and the first step is to include time and comfort as factors in the evaluation of the system. [19] states that one of the imperative points in the Lean is that the entire organization must be examined and included, in order to generate improvements, therefore, in this new paradigm, it is necessary to involve all people in the organization in what it is expected by the patient, and it is necessary to create a permanent flow of people, information and materials creating value, without incurring additional costs for the health organization in question.

In addition, in health care it is necessary to take into account the basis for defining the value for the patient, which is found in the six dimensions of care of the United States Institute of Medicine: (1) safe care, (2) efficient, (3) effective, (4) agile, (4) patient-centered and (5) fair. Everything that is not considered value to the patient is defined as activities that do not add value, or waste [20]. This requires the implementation of quality procedures in the scope of health as a mandatory requirement, which consists of a detailed analysis of the processes involved in carrying out a procedure, including all aspects [21]. The health system is constantly exposed to a seemingly inexhaustible flow of new advances aimed at improving the organizational and operational aspects of the health system, through changes in operations, organization or management principles, given the nature of this sector [4].

Therefore, for [22] the successful implementation of Lean Healthcare can help achieve some objectives, which include (i) Increase the distribution of power among people; (ii) Improved flow; (iii) Eliminate unnecessary expenses; (iv) Align resources and their demand; (v) Make it perfect the first time; (vi) Learn in practice; (vii) Identify problems more easily and (viii) Anticipation of tasks. By applying Lean, organizations can eliminate waste such as overproduction, waiting, transport processing, unnecessary inventory, unnecessary displacement and defects [15].

### **2.2 Lean Healthcare Applications**

As well as Lean Manufacturing, different forms of application of Lean have also been developed within a healthcare environment, because, however much there is a basis for application in manufacturing, when talking about services, adaptation and even insertion of new points in the lean health methodology are necessary [23]. [24] evaluated whether the application of Lean techniques, in a rehabilitation service, reduced waste and added value to the client. Thus, the cost of stored material was reduced by 43% and consumption per treated patient by 19%, increasing the patient's dedication time by 7%.

In turn, [25] evaluated how the 5S management method creates changes in the workplace and in the process and results of health services, and how it can be applied in a

low-resource setting, based on data from a pilot intervention of the 5S program. implemented in a hospital in Senegal. Thus, with regard to efficiency, it was possible to reduce the time to search for items, as well as decrease the movement of the team through the laboratories. Regarding patients, it was possible to reduce the waiting time and also improve the guidelines given to them. Finally, in relation to safety, there was an improvement in the sterilization process. [26] used a case study with a survey of the root causes using the 5 whys tool, questioning the professionals in the focus unit of the work, who had been in it for at least three months. Finally, [27] proposes to study the logistics problems in Brazilian hospitals through Lean methods, approaching different aspects of logistics and the procedures adopted in health institutions such as receiving, storage and transporting.

According to the current literature, emergency and surgical procedures have been the main targets when it comes to Lean implementation [14], so this paper focuses on the medical clinic, specifically on the hospitalization activity of the entrance process, once that there is no paper in medical clinic when it comes to Lean Healthcare [11]. Furthermore, this paper addresses this gap, proposing a systematic application of Lean Healthcare, already applied in a medium-sized Brazilian hospital, presenting positive results exposed in it.

### 3 Method

The methodology of this paper was divided into two pillars - called Lean Survey and Proposal, so that the application structure proposed in previous works [11,13] and, thus, present a systemic application.

In the Survey, the following steps were applied, presented in the study of the process: (i) Mapping of the X-Ray Examination process, through observations made during the day-to-day of the hospital, establishing the times of each activity through the use of the Value Stream Mapping (VSM) establishing the aggregated and non-aggregated values of each activity; (ii) Identification of the waste that occurred in the activity of fetching the next patient, inserted in the X-Ray Examination process. Furthermore, on the waste and Lean proposal section, it was (iii) Established the causes of this waste, with the selection of the greatest number of occurrences to be remedied, using the Pareto Graph; and (iv) Identification of the root cause of the waste to be remedied, using the 5 whys tool.

Then, still in the waste and Lean proposal parte, having identified the root cause, the second pillar, Lean Proposal, began, which unfolded as follows: (i) Lean improvement proposal, related to the identified waste, using an appropriate lean manufacturing tool; (ii) Structure the action plan proposed by [23]; (iii) Apply the actions, following the topics of the schedule. Finally, is (iv) calculate the time savings that the solution has brought to the activity, in the results part.

The purpose of this proposal is that it be executed and made available to those responsible and applied in the future, not only in the activity of fetching the next patient, but in other waste identified in the medical clinic, thus developing a systematic application of Lean Healthcare, which can be used widely.

## **4 Development**

### **4.1 Study Of The Process**

The medical clinic is a complex wing having more than one distinct flow. Thus, it was splinted into three types of flows to be better studied. They are: (i) entry in the medical clinic, (ii) general processes - which include procedures performed on all or most inpatients - and (iii) specific processes - which include specific processes for each patient, based on their needs.

This study covered the specific processes, represented by the flow of X-ray Examination, which exemplifies this process, from the request to the patient's final accommodation.

A current VSM was done about the X-ray Examination, as shows in Figure 1, the VSM begins with the order of order of the X-ray arriving at the medical clinic, from that the responsible nurse identifies the patient who will go for the exam, the bed where he is and so, calls the stretch bearer for transport. When he arrives, he goes to the responsible nurse who delivers the order orders and sends him to the first patient's room to do the exam.

Thus, the activity of preparing the patient begins, which consists of taking him out of bed and placing him in a wheelchair. It is important to note that this flow was limited to patients who need this assistance, which represents a large part of the interns of the medical clinic. Then, stretch bearer directs the patient to the X-ray room, located on the first floor, passing through the hospital's access ramps.

Upon arriving at the room, the stretch bearer delivers the order to the X-ray employee, who begins to set up the machine and the patient for the exam. The stretch bearer waits in the waiting room and, when the exam is over, he returns with the patient to his room and begins the process with the next patient in line, considering that the exam orders are usually sent together to the medical clinic.

Based on this, the application focused on the specific activity of seeking the next patient, who has 40 minutes of non-added value and 28 minutes of added value, due to the long waiting time, that is, non-added value, surpassing the added value of the activity in 12 minutes and all other non-added values of the activities that comprise the process.

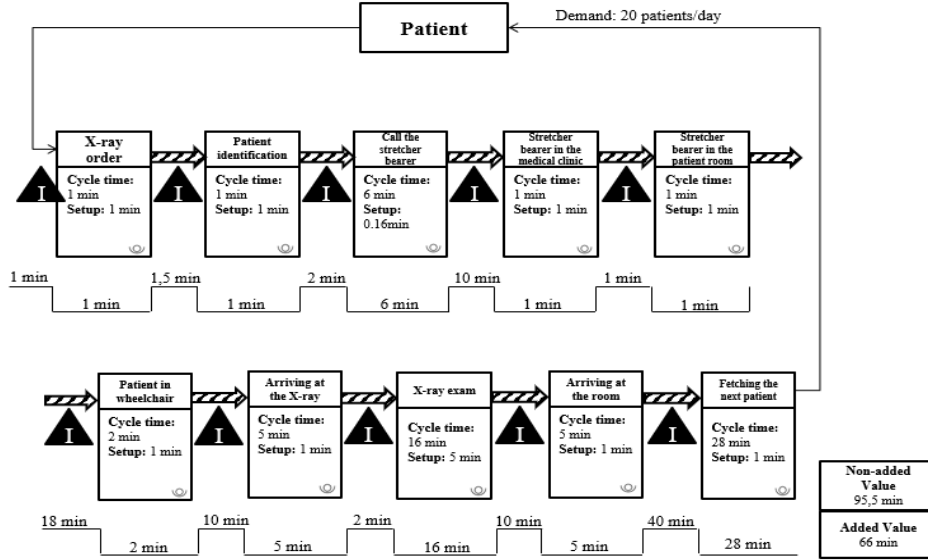


Fig. 1. VSM of the X-ray Examination process.

4.2 Waste And Lean Proposal

From the traced VSM and the daily observations made during the three-month period in the hospital, with a daily demand of 20 patients a day in this process, it was possible to raise the occurrences of non-added value in the fetching the next patient. Thus, the wait for the stretch bearer proved to be the most expressive, and almost unique occurrence, only coexisting with 16% of the times that the wait came from the nurse's specification, as shown in the Pareto Graph in Figure 2.

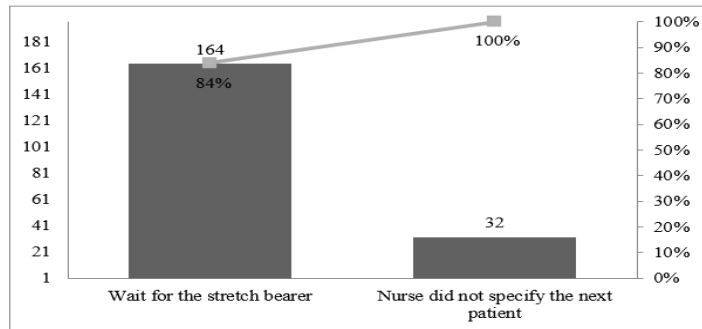


Fig. 2. Pareto diagram for the occurrences of waiting for fetching the next patient

So, the 5 whys tool was used in this first occurrence, to find its root cause, as shows in Table 1. Therefore, it was identified that the root cause of patients' waiting is due to the fact that the stretch bearer only fetches the next one when the exam is over. This



happens because he delivers the patient to the X-ray employee and waits for the exam to finish, however from the moment of delivery, the patient becomes the employee's responsibility, leaving the stretch bearer idle for the duration of the X-ray.

**Table 1.** 5 whys for waiting for the stretch bearer

N	Why	Because
1	Why is the patient waiting for the stretch bearer?	Because the stretch bearer is absent.
2	Why is the stretch bearer absent?	Because he's in the x-ray room.
3	Why is the stretch bearer in the x-ray room?	Because he still hasn't come back from the previous trip.
4	Why didn't he come back from the previous trip?	Because he is waiting for the exam to end.
5	Why is he waiting for the exam to end?	<b>Because he only fetches the next patient when the exam is over.</b>

Thus, the stretch bearer is idle in the waiting room of the examination and the patient already identified by the nurse is waiting for the stretch bearer to pick him up, however he only arrives after the examination and travel back to the medical clinic.

Given its nature, the proposal is a new flow, specifically for the X-ray, in which the activity of fetching the next patient is placed in parallel with the activity of X-ray exam, so that, while the X-ray examination happens, the stretch bearer goes to the medical clinic and fetches the next patient, avoiding idleness and reducing their waiting time.

Figure 3 presents the necessary actions to fully achieve this proposal, following the parameters of the action plan of the *Lean Institute Brasil*.

Action Plan		Objective: Reduce the waiting time for the stretch bearer to fetches the next patient												Department: Medical Clinic					
Task n	Task	Metric	Responsible	Target Date	J	F	M	A	M	J	J	A	S	O	N	D	Review		
1	Meeting with the directors	Meeting held in the room with the directors of the hospital	Applicator 1	Oct-19											O	X		O	
2	Change in the flow	Explain to the stretch bearer the new flow proposed	Applicator 1	Oct-19											O	X		O	
3	Adaptation phase	Moment of adaptation for the new process	Applicator 1	Nov-19												O	X		O
4	X-ray flow	The new flow is incorporated	Applicator 1	From December/2019 to February/2020		X												O	
5	Results recording	Measurement made through observations to compare with initial values	Applicator 1	Mar-20			O	X											O
Prepared by: Applicator 1 and Applicator 2					<b>Caption</b>														
					O Start date X Conclusion date * Review												O On goal V Below goal X Problem		

**Fig. 3.** Action plan and effects for fetching the next patient.

### 4.3 Results

These are the results related to the activity of fetching the next patient. Figure 4 shows the values obtained for this activity and the impact they had in relation to the time originally collected and the post-application, as well as the number of occurrences of the root cause.

Fetching the next patient									
Initial Time					Time Reached				
Total Time	Non-added value	Percentage of non-added value	Added value	Percentage of added value	Total Time	Non-Added value	Percentage of non-added value	Added value	Percentage of added value
68	40	59%	28	41%	20	10	50%	10	50%
Initial occurrences					Occurrences reached				
164					0				

**Fig. 4.** Results obtained with the fetching the next patient

It is clear that the total time from 68 minutes to 20 minutes, this was mainly due to the decrease in the non-aggregated value from 40 minutes to 10 minutes, a decrease of 75%. Due to the activities in parallel, there was also a decrease in the total added value, which went from 28 to 10 minutes, causing an equal distribution between added and non-added value. In addition, the number of occurrences has decreased by 100%, completely eliminating the identified waste.

## 5 Conclusion

With this study, it is possible to recognize the positive results that a systemic application leads to waste in the process activities of a hospital's medical clinic, especially when it comes to Lean.

Regarding the objective of the study, it was possible to achieve it, since a systematic application of Lean Healthcare was proposed in the activity of looking for the next patient in the X-ray examination process.

In addition, the specific objectives were also fulfilled, considering that it was possible to survey the current status of the X-ray examination in patients in the medical clinic wing, through observations made in the day-to-day of the hospital and, mainly, with the use of VSM to establish the activity with the greatest amount of non-added value, in addition to pointing out other activities that have high waiting times, generating the possibility of applying the systematic again.

From the identification of the root cause and the establishment of what type of Lean waste was present in the activity, it was also possible to propose an adequate tool, improving the flow of patients in the process, reducing waiting time, without generating any cost for the hospital.

Furthermore, the proposed application obtained positive results from the Lean perspective, that is, it resulted in a reduction in wasted time, focused on the non-aggregated values of the studied activity. Since these results are promising, using a combination of adequate and systematized Lean Healthcare tools, it is possible to expand the application into more activities to establish the proposed systematic.

In addition, the present study contributes to the Lean Healthcare literature, as it focuses on a hospital ward that is not explored in other applications, that is, in the medical clinic. In addition, the application systematic is a novelty in the literature, as it is fully structured and has practical results, which can be replicated.

Finally, for future research, it is recommended to repeat the application, in order to systematize this proposal, in other medical clinic processes, replicating step by step

what was built, to obtain positive results, from a Lean point of view, and thus, validate the fully systematic in the medical clinic.

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