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Lean Healthcare applied in medicines' preparation in medical clinic at a medium-sized hospital

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Abstract Lean Manufacturing was born with a paradigm shift in production processes, eliminating waste and maintaining quality. This philosophy has continually adapted to other areas, reaching health with Lean Healthcare, which incorporates the same purpose, however it is linked to a sector that demands even greater quality and efficiency, as the risks involve well-being and health of the consumers' lives. Therefore, the objective of this work is to propose an application of Lean Healthcare in the activity of preparation of medicines in the medical clinic. The methodology used is based on two macro phases: the first intends 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. The second macro phase 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, it is expected to improve the hospital's processes, so that they reflect improvements in time and displacement, obtaining concrete information about the implementation of this philosophy, concluding that the practice taken can be replicated in other waste, generating a systematic proposal.

Keywords: Lean Healthcare, Medical clinic, preparation of medicines.

1 Introduction

After establishing itself as a standard American production system, and consequently worldwide, for decades, mass production has been decaying, since there was a need for adaptation to countries that did not fit the molds of the same (ARANTES, 2008).

Thus, the lean production technique was inserted in the means of production, that is, based on the reduction of waste, which was later called Lean Production or Lean Manufacturing (WOMACK; JONES; ROOS, 1990). Lean aims to eliminate waste from companies' processes to make them more efficient and increase their competitiveness, in addition to adding value to their customers (LIKER, 1996).

Lean Healthcare, derived from the Lean Manufacturing, also seeks the total elimination of waste from processes, with the maintenance of the quality provided to consumers, more specifically aimed at the health sector, in which the consumer market is its patients.

Thus, with the increasing application of Lean Healthcare in recent years (BRANDAO DE SOUZA, 2009) the research problem is configured to use, appropriately, the teachings and tools derived from this philosophy to achieve a standard of application that can be replicated in the future.

Thus, the objective of this work is to propose an application of the Lean Healthcare in the preparation of medicines activity in the application of medicines process of the medical clinic, with the specific objectives of: (i) data collectioning the current state of the application of medicines flow from the medical clinic, (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 the results.

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The justification for this work is based, basically, on the benefits that Lean Healthcare can bring to the health service, from the point of view of its processes, linked to the importance that the objective hospital of study has in its region, more specifically the wing of the Medical Clinic, and, finally, his authorization to conduct the study.

It is important to note that other works have already addressed applications made in healthcare environments, however this research addresses a gap in the literature, which is the non-identification of works within the medical clinic, presented in Drei and Ignácio (2019).

2 Theoretical Reference

2.1 Lean Healthcare

Lean Healthcare presents itself, basically, in the application of Lean Manufacturing principles, however specifically in the health sector (SIMÕES, 2009), thus generating the adoption of a philosophy in which its objective is the development of processes within the health system inserted (SILVA, 2012). For Womack and Jones (2004), the application of the Lean in health is perfectly acceptable, and the first step is to include time and comfort as factors in the evaluation of the system.

For Liker (2016), one of the imperative points in the Lean philosophy 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 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 (SILVA, 2012).

Finally, it is necessary to specify some elements of the environment that will align with the characteristics of Lean Healthcare, for example, Silva (2009), brought the following: (i) Purpose: The value can be deducted in solving efficiency problems or patient satisfaction; (ii) Processes: Create value chains to satisfy the objectives; (iii) People: Lead people in order to help value flows and eliminate obstacles to their creation.

From the construction of the Lean Healthcare concept, it is possible to draw an overview of the characteristics of lean health. A priori, it is necessary to understand the types of waste present in the health area, therefore, Silva (2012) presents some types of more common losses present in the hospital environment (TABLE 1).

Table 1 Common types of waste in healthcare. Source: Adapted from Silva (2012).

Types of waste	Description
Waits	Bed allocation, patient discharge, treatment, diagnosis, awaiting medication, approvals waiting for the doctor or nurse;
Excesses	Rework in processes and tests, use of intravenous when oral medication is sufficient, multiple room changes;
Stocks	From samples waiting for analysis, emergency patients, patients waiting for results and materials;
Transportation	Samples, patients, drugs and materials;
Movements	Search for documents and materials, deliver medicines, doctors and nurses treating patients in different wards;
Processes	In the preparation of drugs that are not yet necessary for patients;
Defects	Medication and diagnostic errors, in the correct identification of samples and injuries caused by defective medication.

The elimination or reduction of waste can, in some situations, eliminate processes that do not necessarily need to be done to achieve perfection (SILVA, 2012).

For Granban (2016), the successful implementation of Lean Healthcare can help to 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) making it perfect the first time; (vi) learn in practice; (vii) identify problems more easily; (viii) anticipation of tasks.

2.2 Application Examples

Over the years, as well as in lean manufacturing, different ways of applying the Lean philosophy have also been developed within a health environment, because, however much there is an application base in manufacturing, when talking about services, it becomes necessary to adaptation and even the insertion of new points in the lean health methodology (LEAN INSTITUTE BRASIL, 2019).

Thus, for Dahlgaard, Pettersen and Dahlgaard-Park (2011) their method of applying Lean Healthcare consists of three main steps that are characterized by: (i) understanding the health organization being worked on, (ii) data collection and prioritizing areas for improvement and (iii) measuring the level of excellence, as well as the potential for growth of a level.

Souza et al. (2018) established four steps to achieve its objective, which was to contribute to the identification of the profile of project leaders in the hospital area through an exploratory study in a hospital in southeastern Brazil, which took place by: (i) workshop to define functions and skills of the project leader in Lean Healthcare, (ii) workshop to define the DMAIC method, (iii) analysis of the results of the workshops and (iv) development of the proposed framework.

Finally, Vashi et al. (2019) established visits to the study hospital, then applied a structured questionnaire to employees in the areas of interest and, finally, made quantitative and qualitative analyzes of the responses obtained to thus start the application.

The application discussed in the present study differs from the others in that it is established in the hospital's medical clinic, in order to establish, in the future, a systematic application of Lean Healthcare.

2.3 Lean Tools

Since the global knowledge of lean production, several authors have studied the different sets of tools it encompasses and their effects on performance, primarily from an operational and economic perspective (NEGRÃO; GODINHO FILHO; MARODIN, 2017).

For example, there is Value Stream Mapping (VSM), which is used since the Toyota Production System (TPS) to show the current and future status for Lean system implementation techniques (GUPTA; KAPIL; SHARMA, 2018), as shows Figure 1.

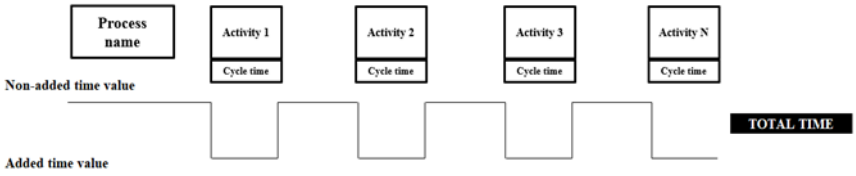
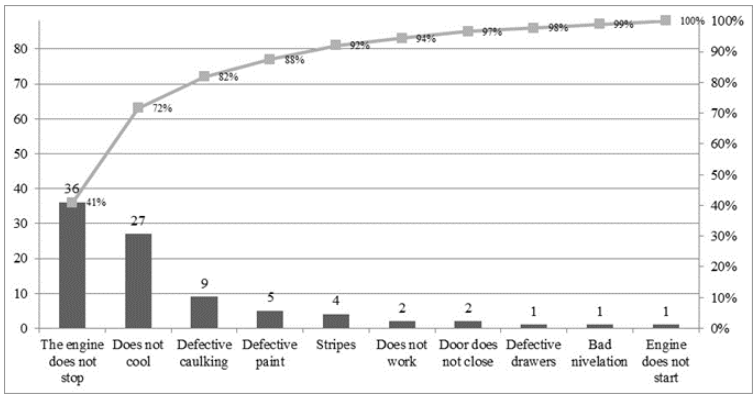


Fig. 1 Lean Healthcare Value Stream Mapping. Source: Adapted from Gupta, Kapil and Sharma (2018).

In addition to the VSM of the current state of the outlined process flow, it is also common to find in the literature the VSM of the Future State, which aims to eliminate the sources of waste identified in the present state map, through a new value stream that can become real in a relatively short period of time (TAVARES, 2017). It is common for the VSM of the future state to be accompanied by Kaizen Bursts, which represent the changes that need to be made to make the current system more similar to the future state map, representing the appropriate Lean tool or concept (CHEN; COX, 2012).

Furthermore, the Pareto Diagram is a graph in which data classifications are organized in descending order, from left to right by means of simple bars after data collection to classify the causes, so that an order of priorities can be assigned.

Thus, Graph 1 shows an example of the Pareto Diagram built to analyze which are the most frequent defects that appear in the refrigerator units when leaving the production line, showing that the most frequent cause is the engine not stopping (SALES, 2013).



Graph 1 Pareto Diagram Example. Source: Adapted from Sales (2013).

Furthermore, it is possible to identify other tools, such as the 5 whys that emerged as a result of Taiichi Ohno's observation in his Toyota days that when mistakes happen in the production or manufacturing environment, people always blame themselves. He realized that mistakes are inevitable and the best approach to mistakes is to identify the causes of the mistakes and act on them (OHNO, 1988).

These are just some of the many examples of tools that Lean philosophy, together with quality, have. Those highlighted in this framework, in turn, play an explanatory role, since they will be used in the application proposed by the work.

3 Method

The methodology of this work is separated into two macro phases, different from each other according to the characteristics of each stage of the process to achieve the final objective. Thus, the first macro phase, called data collection, is constructed by the following steps: (1) mapping of the application of medicines process in the medical clinic, through observations made during the day-to-day of the hospital, outlining each activity in a Value Stream Mapping; (2) identification of the waste that occurs in the medication preparation activity inserted in the outlined process; (3) selection of waste with the highest number of occurrences to be remedied, using a Pareto Diagram; (4) identification of the root cause of the waste to be worked on, using the 5 whys tool.

Furthermore, with the root cause of the waste to be treated, identified, the second macro phase, called the Lean Proposal, unfolds as follows: (1) the Lean improvement proposal related to the identified waste, using an appropriate lean production tool; (2) propose an action plan available in Lean Institute Brasil (2020) with the stages of application and the necessary times; (3) apply the actions, as determined in the schedule; (4) calculate the time and displacement gains that the solution brought to the process.

The expected results will go to carry out and made available to those responsible for the hospital and, in the future, applied, not only in the activity of medication preparation, but in other wastes identified in medical clinic, thus developing a systematic application of Lean Healthcare.

4 Development

4.1 Study Hospital

The hospital that is the focus of the study has a three-story structure, in which access is made by ramps, without elevators. In addition, it also has stairs from the first to the second floor, however these are closed with biometric recognition, having access only to employees.

In relation to the employees themselves, it was necessary to establish the flow by which patients followed until, in fact, they were admitted to the ward of the hospital's medical clinic. Thus, the total flow of medical clinic processes was considered from the moment the patient enters the hospital, until his admission, making the flow encompass, in addition to the ward itself, the hospital reception and the triage of patients.

A priori, reception and triage, as well as the hospital in general, works in 12-hour shifts for 36 hours, that is, there are a total of four different shifts, two of which are in the afternoon - from 7 am to 7 pm - and the other two are nocturnal - from 7pm to 7am.

The Medical Clinic has the same shifts as the hospital, and during the afternoon it has 4 nurses on duty and the night shift has 2. Located on the third floor of the hospital, the beds are distributed between rooms of 2 and 3 beds, totaling 25 beds with addition of 3 emergency, arranged in a room on the second floor.

The 28 beds available for admission to the Medical Clinic are separated into two equal groups between genders, so 14 are male and 14 are female, with an imbalance only if necessary.

In addition, the Medical Clinic has two rooms where nurses responsible for the ward are located, in which one is the bureaucratic room, where patient records, communication with other departments and time control take place, while the other room is the room supplies, where materials are set up, sterilized, among other functions.

In relation to the processes, while the entrance and the triage have a single flow, the medical clinic increases its complexity having more than one distinct flow. Thus, the medical clinic 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 general processes, represented by the flow of medication application, which exemplifies the application of medicines, serums, or other intravenous drugs that patients need.

4.2 Study of the Process

A current VSM was done about medicines application to patients in the medical clinic, as showed in Figure 2. The medication order reaches the responsible nurse. The pharmacy employee, in turn, upon receiving the order, checks the hospital's inventory and returns the call to the medical clinic. The nurse moves to the first floor, where the pharmacy is, picks up the medicine and goes back to the medical clinic. With the medicine in the medical clinic, preparation for its application to the patient begins, which involves taking other devices necessary for the action, such as cotton, syringes, among others, and finally, the nurse moves to the patient's bed and is applied the medicine on it.

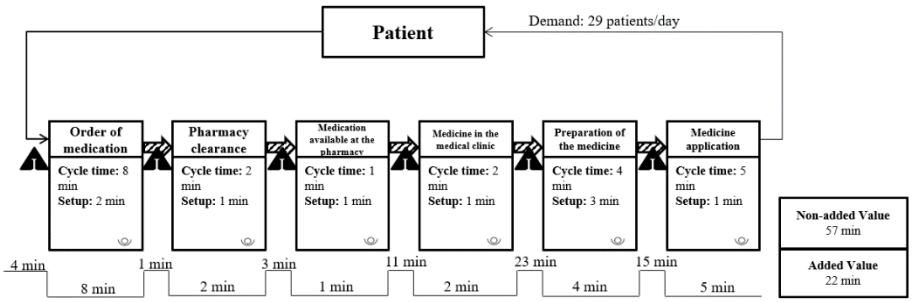


Fig. 2 VSM of application of medicines. Source: Adapted from the study hospital (2020).

Thereafter, the application focused on the preparation of the medicine activity, due to the long waiting time, that is, non-added value, surpassing the added value of the activity in 19 minutes and all other non-added values of the activities that comprise the process.

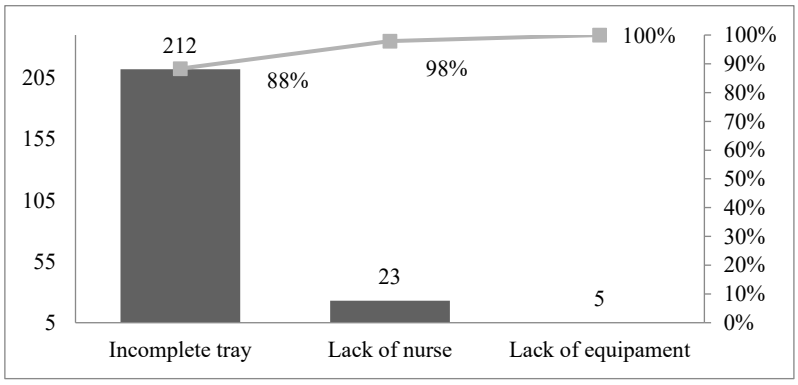
4.3 Waste and Lean Proposal

Following the VSM presented, an average wait of 23 minutes per patient is identified for your medication to be prepared. Thus, the occurrences of this waiting took, expressed in Table 2.

Table 2 Occurrences of waiting for preparation of medicines.

Wait occurrences	Frequency	Percentage	Accumulated percentage
Incomplete tray	212	88%	88%
Lack of nurse	23	10%	98%
Lack of equipment	5	2%	100%
TOTAL	240	100%	100%

Using the frequency of each occurrence, a Pareto diagram was also constructed, as shown in Graph 2, showing the percentage of each one, as well as the accumulated one.



Graph 2 Pareto diagram for the occurrences of waiting for the preparation of medicines.

It is possible to notice that the incomplete tray was the occurrence that caused the most waiting in the preparation of the medication, so the 5 whys were done with it, as shown in Table 3.

Table 3 5 whys for waiting for preparation of medicine.

N	Why	Because
1	Why is the tray incomplete?	Because some materials were not placed the first time.
2	Why weren't some materials placed?	Because the nurse forgot.
3	Why did the nurse forget?	Because he didn't identify it in the preparation room.
4	Why didn't he identify in the preparation room?	Because the preparation room does not have a verification flow.
5	Why doesn't the preparation room have a material verification flow?	**Because there is no final check of all materials.**

Thus, the root cause of the non-added value in the preparation of the tray is the lack of proper demarcation for the materials that compose it. Since the room does not have any type of sign showing where each piece of equipment should be, the assembly is not intuitive and, thus, the responsible nurse ends up taking the tray with missing materials, making him move to the room and back to the room of the medical clinic more than once.

This waste is part of Lean movement and, therefore, the proposal is the application of a checklist (FIGURE 3) in the preparation room of the medical clinic, so that the tray is checked before leaving the preparation area.

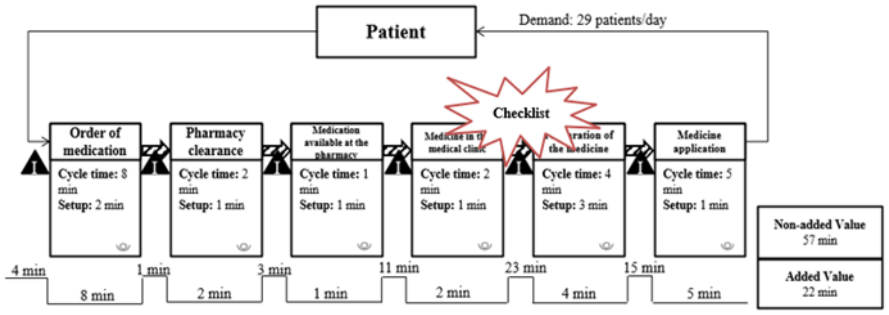


Fig. 3 Kaizen burst of the proposal to wait for the preparation of the medicine. Source: Adapted from the study hospital (2020).

Thus, Table 4 shows the actions for implementing the proposal, as well as the goals of this change.

The tasks follow the action plan and the process goal is represented by reducing the distance covered by the nurse by up to 40 steps - due to the average in each application during the observation days - and the patient's waiting time by up to 23 minutes.

Table 4 Action plan and effects for preparation of the medicines.

Action plan		**Objective:** To reduce the waiting time for the preparation of medicines														**Department:** Medical Clinic
Task n	**Task**	**Metric**	**Responsable**	**Target date**	**J**	**F**	**M**	**A**	**M**	**J**	**J**	**A**	**S**	**O**	**N**	**D**	**Review**
1	Meeting with directors	Meeting held in the room with the directors of the hospital	Applicator 1	Oct-19										O/X			O
2	Change proposal for nurses	Explain the proposed checklist to the responsible nurses	Applicator 1	Oct-19										O/X			O
3	Adaptation phase	Adaptation time for the new process	Applicator 1	Nov-19											O/X		O
4	Change in the preparation of medicines	The medication tray starts to leave the preparation area only after those responsible have checked the list	Applicator 1	From Dez-2019 to Feb-2020		X										O	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				**Legend** **O** Begin date **X** Conclusion date * Review													**O** Goal **V** Below the goal **X** Problem

4.4 Results

There are the results related to the activity of preparation of medicines of the hospitalized patient. After identifying the poor organization when preparing the material tray, due to the lack of demarcation of what is necessary for each medication, a checklist was proposed, in order to have a check at the end of each assembly, thus avoiding unnecessary displacement and decreasing the waiting time.

Thus, Table 5 shows the values obtained for this activity and the impact they had in relation to the time originally raised and the post-application, as well as the dislocation of nurses in steps.

Table 5 Results obtained with the preparation of medicines.

PREPARATION OF MEDICINES									
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
27	23	85%	4	15%	12	8	67%	4	33%
INITAL DISLOCATION					DISLOCATION REACHED				
40					6				
NUMBER OF INITIAL OCCURRENCES					NUMBER OF OCCURRENCES REACHED				
212					13				

It is clear that the total time from 27 minutes to 12 minutes, this was mainly due to the decrease in the non-aggregated value from 23 minutes to 8 minutes, a decrease of 65.21%, making the aggregate value of activity increased from 15% to 33% of the total time.

In addition, the nurse's unnecessary displacement between the preparation room and a patient's room, which was, on average, 40 steps per application, became 6 steps, that is, a decrease of 85%. In addition, the number of occurrences decreased by 93.9%.

5 Conclusion

Through this study it is possible to recognize the positive results that a congruent application can cause waste in the activities of processes that make up the medical clinic of a hospital, especially when it comes to lean philosophy.

Regarding the objective of the work, it was possible to achieve it, since it was possible to propose an application, using the Lean Healthcare philosophy, in the activity of preparing the medicines in the medical clinic. In addition, it was also possible to data collection the patient's inflow, through observations, use appropriate tools and apply a viable solution to the identified waste.

It is important to note that the proposed application obtained positive results from the perspective of Lean, that is, resulted in a reduction of time waste, focused on the non-aggregated values of the medication preparation activity, included in the medication application process. In addition, the present study also contributes to the lean health literature, since it focuses on a hospital wing that is not explored in other applications.

Finally, as future work, it is recommended to systematize this proposed application, in other processes that make up the medical clinic, replicating step by step of what was built, to obtain positive results, from the Lean point of view and, thus, validate systematics in medical clinic altogether.

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