Value Flow Map: application and results in the disinfection center

Mapa de Fluxo de Valor: aplicação e resultados na central de desinfecção

Mapa de la Cadena de Valor: aplicación y resultados en el centro de desinfección

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ABSTRACT
Objective: To identify and eliminate steps that do not add value for customers in the disinfection center. **Method:** We applied the *Lean* tool: Value Flow Map, using the concepts of *gemba* and *kaizen* in the work process of the disinfection unit for ventilatory care materials, aiming at improving such process. After performing a training with the team on the *Lean* concepts described above, applying the Value Flow Map in the *gemba*, analyzing the opportunities for improvement, and approving the changes, the Value Flow Map of the future state was devised and changes were implemented. **Result:** The time of the disinfection process was reduced in 2h37 and the financial resources required also decreased, in R$ 809.08/month. **Conclusion:** The application of *Lean* concepts presented positive results for the elimination of wastages in the disinfection center.
Descriptors: Disinfection; Hospital Administration; Cost Reduction; Health Care Quality; Quality Management.

RESUMO
Objetivo: identificar e eliminar as etapas que não agregam valor ao cliente na central de desinfecção. **Método:** foi aplicada a ferramenta *Lean*: Mapa de Fluxo de Valor, utilizando os conceitos *Gemba* e *Kaizen* no processo de trabalho da unidade de desinfecção de materiais para uso na assistência ventilatória com o intuito de melhorar o processo de trabalho. Foi realizada a capacitação da equipe em relação aos conceitos *Lean* descritos acima, foi aplicado o Mapa de Fluxo de Valor no *Gemba*, foram analisadas as oportunidades de melhoria e, após, aprovação das alterações, foi desenhado o Mapa de Fluxo de Valor do estado futuro e implementadas as mudanças. **Resultado:** obteve-se redução de tempo em 2h37 no processo de desinfecção e redução de recursos financeiros em R$ 809,08 reais/mês. **Conclusão:** a aplicação de conceitos *Lean* apresentou resultados positivos na eliminação de desperdícios na central de desinfecção.
Descritores: Desinfecção; Administração Hospitalar; Redução de Custos; Qualidade da Assistência à Saúde; Gestão da Qualidade.

RESUMEN
Objetivo: identificar y eliminar los pasos que no agregan valor para los clientes en el centro de desinfección. **Método:** aplicamos la herramienta Lean: mapa de la cadena de valor, conceptos de gemba y kaizen, en el proceso de trabajo de la unidad de desinfección para materiales de asistencia ventilatoria con el objetivo de mejorar el proceso. Después de realizar una capacitación con el equipo sobre los conceptos Lean descritos anteriormente, aplicamos el Mapa de la cadena de valor en el gemba, analizamos las oportunidades de mejora y aprobamos los cambios; se diseñó el Mapa de la cadena de valor del estado futuro y se implementaron los cambios. **Resultado:** el tiempo del proceso de desinfección se redujo en dos horas y treinta y siete minutos, y los recursos financieros requeridos también disminuyeron en R$ 809,08/mes. **Conclusión:** la aplicación de los conceptos Lean presentó resultados positivos para la eliminación de desperdicios en el centro de desinfección.
Descriptores: Desinfección; Administración Hospitalaria; Ahorro de Costo; Calidad de la Atención de Salud; Gestión de la Calidad.

INTRODUCTION

The Material and Sterilization Center (CME) is defined as a functional unit targeted at the processing of health products. Its mission is establishing care and diagnosis services with processed materials, ensuring the required quantity and quality for a safe care[1].

Among the units of a CME is the Disinfection Center (CD), which is responsible for the processing of respiratory medical-hospital items that require high-level disinfection. High-level disinfection is a physical or chemical process that destroys most microorganisms of semi-critical items, including micro-bacteria and fungi, except for a high number of bacterial spores[1]. The CME is part of a relevant support sector to the health institution, related to the quality of the services provided[2]. The CME and CD correspond to the sector within the hospital that has the characteristics most similar to the industrial work process, as it is a production line.

According to experts from the World Bank (IBRD) in the report called "*Hospital Performance in Brazil* – the search for excellence," the hospital network of the country is highly stratified and unequal in efficiency. The conclusions of this publication are disturbing for public health: few Brazilian hospitals can be regarded as what the authors call *world-class centers of excellence*. Most hospitals providing services to the Unified Health System (SUS) are described as being below the internationally accepted standards and many are in disagreement with the Brazilian sanitary legislation. These units do not easily adapt to changes, using outdated management practices and methods. A decisive element for determining the efficiency of a hospital is how it makes use of the resources available for producing treatments and other clinical or non-clinical services. The inappropriate application of resources impedes the efficient provision of services, compromises quality, and results in higher costs. Although hard to define and even harder to operationalize, quality is usually accepted as a determining factor for judging the performance of a hospital. These hospitals – that depend on public funding – are "ineffective and low quality." The optimization of such hospitals requires changes in the management form[3].

A managerial model that has been used in the health area, whose origin is in the automobile industry, is known as *Lean* or lean philosophy. The objective of *Lean* is identifying wastes, eliminating all that does not add value for the client, aimed at increasing the process efficiency and product quality. In the field of Health, this philosophy is called *Lean Healthcare*, and the results of its application in hospitals include the search for improving the aspects related to patient and collaborator safety, customer and worker satisfaction, reduction of hospital stay length and financial resources[4-5].

One of the tools commonly applied in the Lean philosophy, both in industry as in Health, is the Value Flow Map (VFM). The VFM is a diagram that shows in details the steps of a work process, including the flow of people, materials, and information. The purpose of VFM is facilitating the visualization and understanding of the work process and allowing an improvement through the elimination of steps that do not aggregate value to the client, by considering if there is a safer, more efficient or effective option. The VFM must be created by a multidisciplinary team that includes workers in the *gemba* with the realization of a *Kaizen* event [6].

The *Kaizen* event, translated from Japanese as an ongoing improvement, corresponds to the team meeting during one to three days for analyzing a given process. During such event, the so-called "*gemba* walks" are performed – "*gemba*" is the location where the work processes occur. Such strategy aims at involving all those who interact in the steps of the activities under scrutiny, so to develop the managers' and teams' ability in identifying wastes, as well as to align their expectations[7].

In a study in which the *Kaizen* event was performed, the VFM was applied, enabling the visual description of each step of a process using parameters such as time; number of professionals, providers, and the relations with other processes and sectors; and, mainly, the identification of points for improvement[8]. Hence, two maps are devised: the map of the current state, with improvement opportunities; and the map of the future state, with the solutions defined by the team.

OBJECTIVE

To identify wastes in the disinfection process of materials for ventilatory care and to implement improvements.

METHOD

Ethical aspects

This study was approved by the Research Ethics Committee of the University of Campinas.

Theoretical-methodological framework

In the *Lean* philosophy, knowing the current state of the environment studied is of utmost importance before proposing any significant change. In this study, information on the unit was gathered for knowing the current state and, from a joint analysis between the institution's researchers and collaborators involved in the process, it was possible to understand which activities did not add value for customers. Such understanding was achieved in *Kaizen* events through *brainstorming*.

Type of study

Descriptive study, of before-and-after type, in which a *Lean* managerial tool was applied according to its operational definition, described by Rotteret et al.[9]. In this definition, the key features of *Lean* include the (i) *Lean* Philosophy, which comprises its principles and the concept of ongoing improvement, whose main objective is transforming the work environment culture; and (ii) *Lean* Activities, a set of practices, tools, or techniques used for two specific goals: assessment and improvement[9].

Lean activities include eliminating wasters; improving the flow of patients, professionals, and providers; and ensuring that all processes add value for the customer[10]. The *Lean* principles also recommend the identification and resolution of problems by front-line collaborators of the process, who are considered to be those with the greater potential for devising solutions[11]. *Lean* assessment activities, in turn, enable the collaborators of a given

team to identify wastes and areas for improvement[9]. The following concepts were used in this study: *Kaizen* event, *gemba* walks, and Value Flow Mapping (VFM).

From then, one follows a planning period form applying changes through *Lean* (ii) improvement activities[9]. Such activities are directed at reducing wastes, improving the work environment, and establishing new practices[12]. In this study, we standardized the process defined from solutions found by the team.

Methodological procedures

Firstly, the project was presented to the workers involved in the study area. A meeting was held to explain the *Lean Healthcare* philosophy, the goals of the study, its relevance for the institution, in addition to what was expected from each member.

To initiate the work process of this investigation based on the *Lean* system, we relied on the participation of a multi-professional team consisting of six professionals, being five nurses – one of them a *Lean* philosophy tutor – and a doctor – the Lean consultant –, who participated in all steps of the research process.

Study scenario

The study was conducted in a medium-size university hospital in the countryside of the São Paulo State, with 410 beds, of which 63 were in the Intensive Care Unit (ICU). Such hospital is subdivided into outpatient clinics, a surgical center with 12 elective surgical rooms, four urgency surgical rooms, and 10 outpatient surgical rooms. The CME consists of four units, being one general and three satellite units: endoscopy, disinfection, and delicate materials (Figure 1). In this study, the intervention was carried out in the disinfection sector. The disinfection center (CD) is a CME unit responsible for the high-level disinfection of respiratory materials. This CME sector works from Monday to Friday from 7 a.m. to 7 p.m. and has a team of six nursing technicians and a nurse, being the latter responsible for the satellite units of the CME. The work process analyzed occurs once a day in the CD, and the sterilization process of drapes and aprons used in the CD happens once a day in the CME.

Data source

The population comprised professionals from the CD and the multi-professional team, according to the six elements described above. Inclusion criteria were working in the sector for at least six months, knowing the work process to be analyzed, being present at the time of data collection, and agreeing to participate in the study. A critical-care nurse, a member of the multi-professional team, nursing technicians and the nurse director of the area participated in the study.
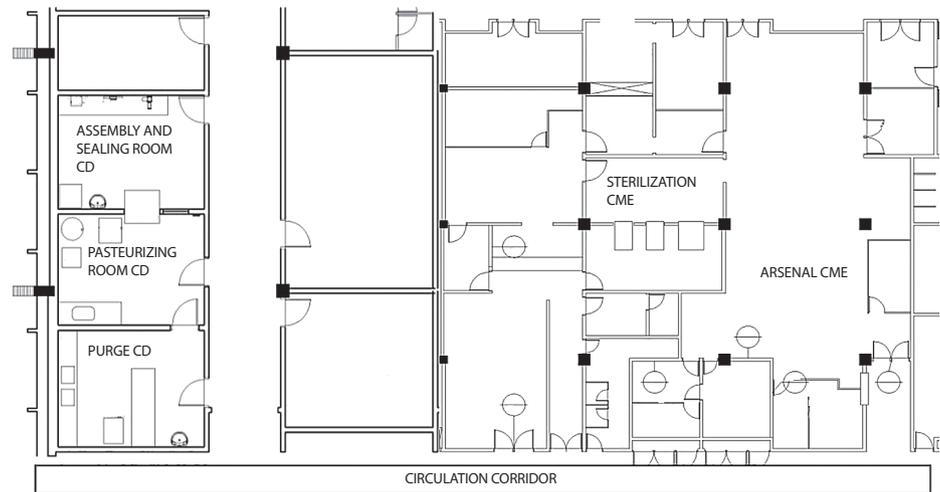

Figure 1 - Physical plant of the Material and Sterilization Center and Disinfection Center, Campinas, São Paulo, Brazil, 2018

Data collection and organization

The proposed method used was the *Kaizen* event, composed of the steps: *kaizen* meetings, problem identification, team formation, team training, current VFM drawing, future VFM drawing, CME and CCIH validation, collection of data on the identification of wastes, study approval meeting, implementation, and final report – which culminated in the article.

To initiate the process, meetings were carried out with the CME direction along with the nursing department for identifying the problem. Given this, a multi-professional team was formed so we could work on the problem identified.

Considering the scarce knowledge on *Lean* by the CME team and directors, the consultants performed a 16-hour training about the tools and concepts used in this study.

After team training, we went to the disinfection unit, the location where the process actually occurs (*gemba*), and devised the VFM of the current state. A semi-structured script was used, including all information required for a VFM. After that, the writing of a report considered the remarks made by professionals and the important points of the participants' speeches, as well as the activities performed, and nonconformities observed. All data collection occurred within the own study unit.

In this phase, the aim was at identifying the steps that occur during the process performance, measuring the time periods of material processing. After drawing the VFM of the current state, more Kaizen events were conducted to discuss the steps described in the VFM. The VFM analysis identified the activities that add value, required activities that do not add value, and activities that do not add value. After each team member's analysis on the current VFM, the VFM of the future state was devised, eliminating steps that did not add value.

The VFM of future state was validated with the CME team and with the Hospital Infection Control Center (CCIH) to ensure process quality. After approval, we returned to the *gemba* and, in a meeting with the team, implemented the improvements and eliminated wastes.

The value flow mapping process, the implementation of improvements to eliminate wastes. and the new VFM were developed from June 2017 to March 2018.

Data analysis

Variables considered for data analysis were time and cost of materials.

RESULTS

The processing of ventilatory care items happens in first (purge), second (disinfection room), and third (material preparation room) phases.

The design of disinfection process steps of ventilatory items are represented in Figure 2.

When analyzing the VFM with the interdisciplinary team, it was observed that sterilized drapes, aprons, and gloves were used to handle materials that did not require sterilization for use, as the high-level disinfection process is enough to ensure patient safety. After such finding, a change of routine was taken to the CCIH to analyze its viability. The CCIH experts authorized removing the use of sterilized drapes from the routine, keeping the cleansing of transportation means and the environment in all steps of processing, provided that it was done with 5th-generation ammonium quaternary and polymer biguanide and double cotton lining with about 250 g/m² clean grammage. We also analyzed the use of non-tissue, non-sterilized, 100% polypropylene disposable aprons and procedure gloves without talcum powder. The use of surgical masks with triple stripes was already performed and remains in this process. The VFM was redesigned with the approval of changes described above, which are represented in Figure 3.

To assess the cost of waste reduction, the current values of the year (2018) considered in the bidding were identified. As for the sterilization, the value was US$ 1.07 per piece of clothing[13]. Costs of materials corresponding to the VFM of current and future states are described in Table 1.
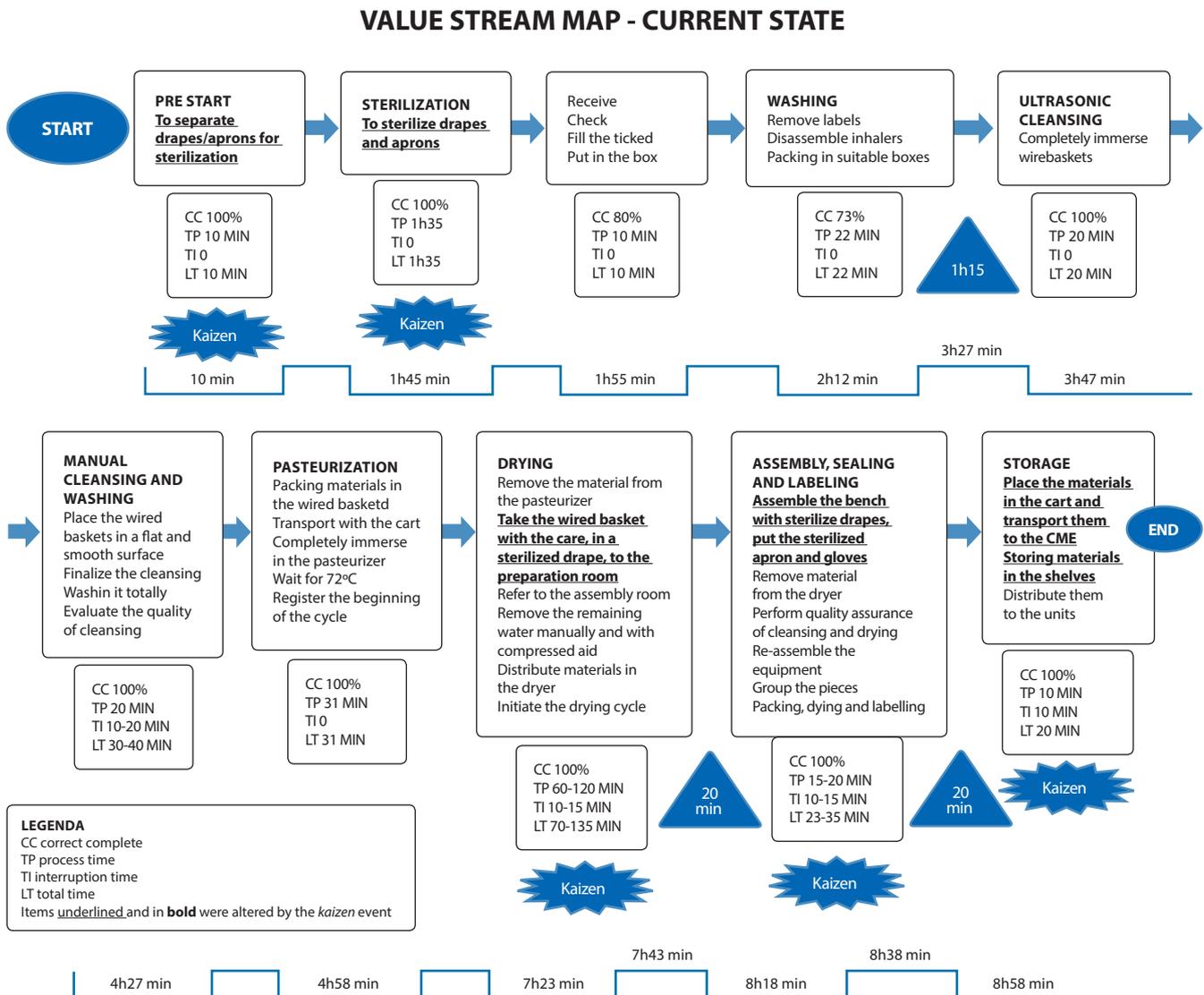
VALUE STREAM MAP - CURRENT STATE

Figure 2 - Value Flow Map before the changes, Campinas, São Paulo, Brazil, 2018
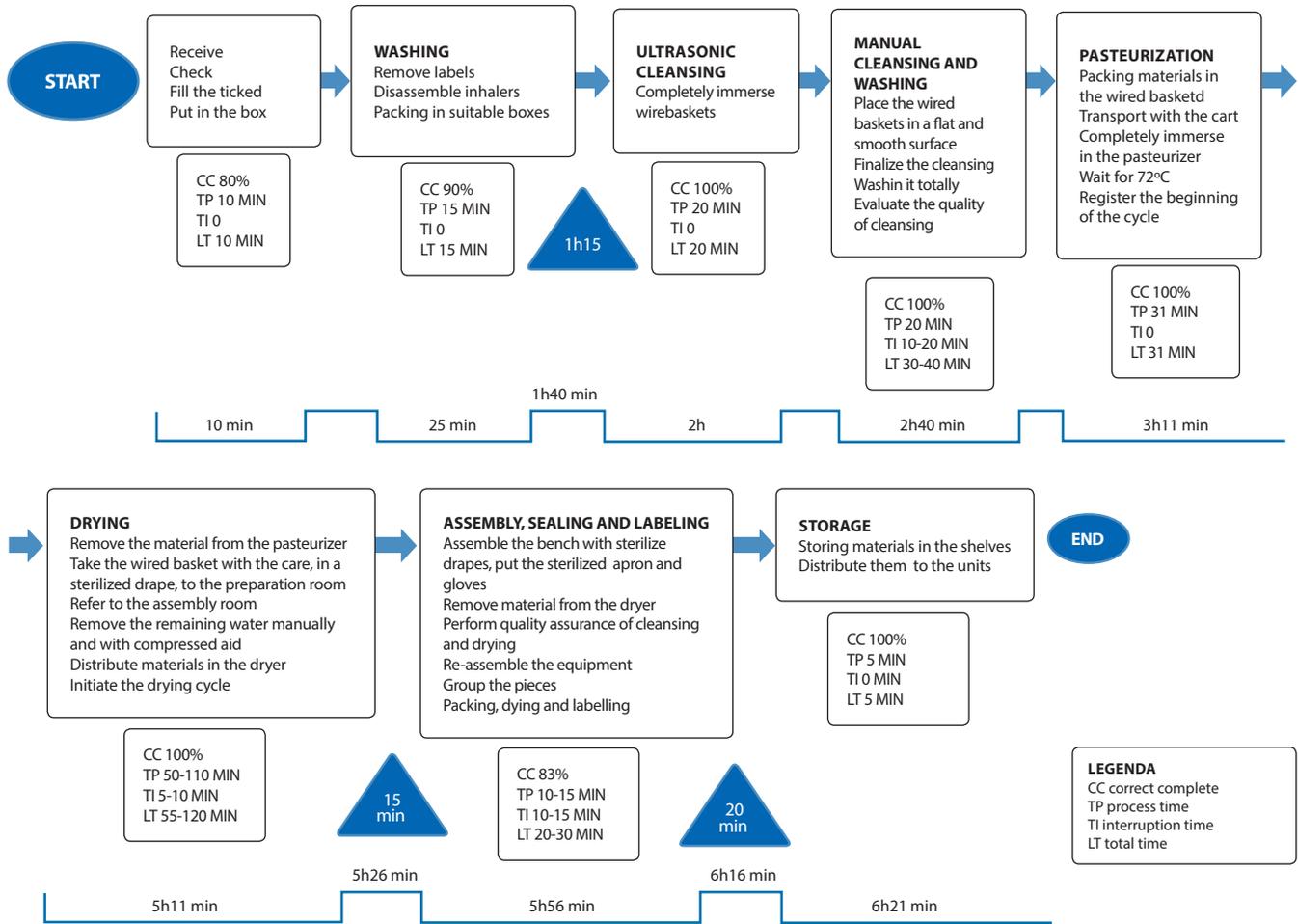
VALUE STREAM MAP - FUTURE STATE

Figure 3 - Value Flow Map after wastage elimination, Campinas, São Paulo, Brazil, 2018

Table 1 - Cost of materials before and after work process review, Campinas, São Paulo, Brazil, 2018

Material	Quantity	Unit value	Total before process review	Total after process review
Cloth aprons washing	180	R$ 1.77	R$ 318.60	R$ 0.00
Sterile gloves P	100	R$ 0.77	R$ 77.30	R$ 0.00
Sterile gloves M	220	R$ 0.77 (US$1.07)	R$ 170.06	R$ 0.00
Sterile charge	180	R$ 3.50	R$ 630.00	R$ 0.00
Procedure gloves P	2	R$ 12.36	R$ 0.00	R$ 24.72
Procedure gloves M	6	R$ 12.36	R$ 0.00	R$ 74.16
Disposable aprons	180	R$ 1.60	R$ 0.00	R$ 288.00
Monthly total			R$ 1.195.96	R$ 386.88

With the changes in the work process, there was a saving of R$ 809.08/month out of the values given above, by simply ceasing to use sterilized aprons and drapes and sterile gloves. This study did not make accounts of the time of the nursing team nor of the purchase value of cotton aprons.

During process review, we eliminated the step of drapes and aprons sterilization, as well as the transportation of ready-to-use materials to the CME, leading to a reduction of 2h37 minutes/day. Therefore, in 12h of CD work, 2h37min were eliminated.

DISCUSSION

The option for adopting the *Lean* philosophy occurred after the deepening of published articles focusing on the use of this working tool as a positive method to be applied in the Health field.

In a literature review in which the authors analyzed 33 articles, a broad range of *Lean* applications was found[14]. The articles describe its implementation steps and technical aspects, demonstrating positive results. There was interrelation in the contextual aspects of different component of *Lean* intervention, which resulted in four different mechanisms of change: understanding the process in a shared manner; organizing a projecting process steps to achieve efficacy and efficiency; improving the detection of errors to increase awareness and process reliability; and collaborating to systematically solve problems for an ongoing improvement[14].

Another aspect to be considered in the *Lean* is the rapprochement of the manager to the "shopfloor," i.e., *gemba*, legitimizing the identification of focuses for change with the participation

of the entire team that works in the location. In this study, the managers' going to the *gemba* allowed helping collaborators to think why the processes were conducted as such and, together, to identify wastes.

From data collection and visits to the study location, we have detected wastages that could be an obstacle to process efficiency. Such obstacles negatively interfere with care provision since the material processing time was higher than necessary, thus reducing the availability of material to care units, which may compromise the patient's clinical development. In an article comparing two managerial models, Total Quality and Lean, the first model is focused on the observation, whereas in Lean there is a de-bureaucratization and speeding up of the process[15].

The use of VFM enabled the detailed visualization of the work process. For being involved with the routine, the team that performs the work is not fully attentive to the intermediate steps of the process, involuntarily undervaluing what increases or not value for customers. Usually, the routine makes the process occur in a way that only the final product is regarded. Analyzing the VFM with the team allowed them to abandon the thinking focused on the product as a substance to, then, think of the customer, conveying more meaning to the work performed. A study comparing two managerial models, Total Quality and *Lean*, identified that the latter was more appropriate because it allowed workers to be part of the process of change, leading to a greater workers' adherence to problem-solving and to the search for continuing improvement[15].

The use of *kaizen* events, responsible for the implementation of changes, was of utmost importance for the implantation and continuity of improvements. Kaizen events were important for the teams to leave the routine environment and reflect on the work process steps that were described in the VFM. Contributions given by the operational and multi-professional teams were of great value for the improvement of the work process. In addition, the workers felt valued for being heard and for being part of the process of change.

In a systematic review that analyzed 59 articles, those that discussed the VFM and the modified *kaizen* events are examples that one can obtain positive results by aligning traditional values and wastes with the respective environmental and social ones, considering the approaches and values of customers, environment, and society and focusing on the decrease of both productive as environmental wastes[16].

When analyzing the final step of the process, with the lining of cart and bench with sterile drapes and the placing of sterile gloves and aprons, it was observed that, even though the sterilization process did not occur within the CD, it added time, people, and material resources that had not been accounted for until then. Such questioning was raised by a person who did not belong to the work process. When searching in the literature for references on the removal of sterile materials, the SOBECC guidelines were found.

The implementation of *Lean* tools should consider the quality-productivity relation. Processes and patients' safety must be prioritized, i.e., the increased productivity is only feasible when it does not negatively impact the quality[9]. The removal of sterilized gloves, aprons, and drapes followed literature recommendations[17]

and institutional support through the approval by the CCIH and management coordination.

One of the consequences of *Lean* is the cutting of wastes, including financial wastage. This study indicated the elimination of time and financial resources. In addition, talents were better used as, after the VFM training, people who were working in the CME realized its applicability in other processes in the same work environment.

The main impact arising from the application of this method in Health are: increased productivity, team efficiency, and standardization of care processes; cost reduction; improvement of teamwork; reduction in patients' stay; increased quality of the service delivered; greater patient satisfaction; increased patients' and health professionals' safety; and worker satisfaction[18].

Study limitations

This study had some limitations related to the availability of methods to implement the philosophy, with little research regarding the application of *Lean Healthcare* in the CME. Other limitations were related to the values of financial resources calculated in this study, as it did not include values concerning human resources, the price of the institution's sterilization cycle, and the purchase of cloth aprons.

Contributions to the Health field

The *Lean Healthcare* philosophy promotes quality and the search for ongoing improvement in all aspects involving the health institution, upgrading processes and developing a personalized care, meeting the specific needs of the customer. The CME is an area within the health institution that interrelates to the entire hospital, as it processes materials for all sectors of a hospital area or health service and, if not performed with quality, the patients' health is compromised, and the health costs increased.

Thus, the *Lean Healthcare* fetches management tools able to bring benefits to the institution regarding process standardization, time and financial resources optimization, and work process qualification. For being successful in implementing the Lean, it must be based on the rapprochement between manager and professionals involved in the process, thus legitimating the leadership and helping support the changes. As the *Lean* seeks customer satisfaction, it is important that satisfaction indicators are constantly assessed and that Lean tools are constantly applied in the process, aiming at continuous improvement.

CONCLUSION

The VFM tools, in addition to the *gemba* and to *Kaizen* events, proved to be adequate for identifying focuses of the waste of human and financial resources. Professionals felt valuated, as they were heard and integrated into the process of change.

Lean philosophy was of easy applicability and promoted the rapprochement between manager and work team, making the first one to experience the work process for being at the *gemba*.

Further qualitative studies on the *Lean Healthcare* are suggested, as the approach of this method is very centered on the valuation and

respect to the professional. In addition, the focus of Lean philosophy is customer satisfaction; therefore, we suggest research that use instruments to measure patient satisfaction after the application of *Lean* tools, to asses if they really improve such indicator.

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