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ANALYSIS OF THE LEAN HEALTHCARE UTILIZATION IN THE CONTEXT OF PHARMACEUTICAL SERVICES

Andre Teixeira Pontes
atpontes@id.uff.br
Universidade Federal Fluminense – UFF, Niterói, Rio de Janeiro, Brasil.

Istefani Carisio de Paula
istefanicpaula@gmail.com
Universidade Federal do Rio Grande do Sul – UFRGS, Porto Alegre, RS, Brasil.

Elaine A. R. de Campos
earcamp@gmail.com
Universidade Federal do Rio Grande do Sul – UFRGS, Porto Alegre, RS, Brasil.

Edyane Lopes
edyanelopes@hotmail.com
Secretaria de Estado de Saúde do Rio Grande do Sul – SES, Porto Alegre, RS, Brasil.

ABSTRACT

Background: Expenses with medicines are relevant and growing in health sector. Therefore, Pharmaceutical Services (PS) operations are designed to play a significant role in improving the social and economic contexts of health.
Objective: This article aims to analyze if the Lean Healthcare (LH) practices have been contributing to the improvement of the PS processes.
Methods: This study is based on PRISMA guidelines. The search was made in the literature through databases, such as Web of Science, Scopus, Medline (via PubMed), and Embase. In this study, 2878 identified papers were screened. Articles published up to the end of 2017 (and considering a 10-year period) were surveyed. In total, 43 studies met the pre-defined inclusion and exclusion criteria for data analysis in this work, 37 of which were published in 25 periodicals and six in congresses.
Results: United States and United Kingdom concentrated 65% of the articles. A predominance of studies was observed in the context of the Hospital Pharmacy sector, emphasizing the LH practices in the Distribution and Use steps in the PS context.
Conclusion: The literature on lean thinking applied in the specific context of the PS is relatively recent and scarce, highlighting a more pronounced growth in recent years. It was verified that LH practices in PS have been applied with more emphasis on reducing time and waste of resources, while contributing to process improvement and increased patient safety.

Keywords: Lean Healthcare; Pharmaceutical Service; literature review

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1. INTRODUCTION

The health sector is vital for the society and requires many resources for its full operation. Among these resources are medicines, which are the main agents in the cure and care processes of considerable financial relevance; their costs are growing in Brazil due to the population (Pinto; Osorio-de-Castro, 2015). The management of all drug-related processes, including their rational use, is called Pharmaceutical Service (PS), and its operational complexity might generate waste.

In Brazil, the Pharmaceutical Services involve research, development, and production of medicines and inputs, as well as their selection, scheduling, procurement, distribution, dispensation, quality assurance of products and services, and the follow-up and evaluation of their use, in the perspective of obtaining concrete results and improvement in the population's quality of life (Brasil, 2014).

Considering the Brazilian context, structuring the Pharmaceutical Services is one of the great challenges for managers, either due to the financial resources involved and due to the need for continuous improvement, searching for new strategies in their management (Pontarolli, 2007).

In Brazil, failures that can cause the population to not be provided with the necessary medicines have been contributing to the worsening of the health conditions of the individuals, besides enabling an increase in the judicial demands for medication. Such facts have an impact on the increase in the expenses and contribute to a service breakdown, generating a negative cyclical effect (Machado *et al.*, 2011; Pinto; Osorio-de-Castro, 2015; Catanheide et al., 2016).

The complexity of such system becomes evident, considering that the PS is operationalized by almost ten operations involving other tens of stakeholders, such as health professionals (physicians, pharmacists, nurses, psychologists, social workers, and others), decision-makers, pharmaceutical business managers, producers, and distributors, among others. The chances of failures in the interfaces between the involved parties and within the operations make PS a target for the application of LH practices, aiming to optimize processes, reduce waste, and increase reliance, process robustness, and professionals' resilience, thus providing better patient care. Everything happens in a complex environment with limited resources.

Studies indicate PS management-related issues in Brazilian municipalities, generating drug shortages and increased costs that impair the population assisted (Bruns et al., 2014; Pimenta-de-Souza et al., 2014; Pinto; Osorio-de-Castro, 2015; Fialho *et al.*, 2016; Rover *et al.*, 2016; Rodrigues *et al.*, 2017). This scenario justifies the application of Lean Healthcare (LH), aiming to minimize losses.

Lean Manufacturing refers to a management type focused on identifying and eliminating activities that do not add value (Yamamoto et al., 2010).

The growing utilization and adaptation of the Lean in the health sector, especially in the hospital environment, has generated what is known as Lean Healthcare. The Lean interventions in the health sector aim to improve healthcare quality, thus reducing the waste and facilitating the flow in the work processes (Shazali *et al.*, 2013; Andersen et al., 2014; Al-Hyari *et al.*, 2016).

LH has been used in several health sectors, including the Pharmaceutical Services, aiming to reduce the error rates, optimize service, reduce costs, promote employees' engagement, improve patient satisfaction, and decrease the mortality rates (Hlubocky et al., 2013). From the knowledge point of view, the LH utilization in the health sector is relatively recent, with the first cases dating from 2005-2007 (Womack *et al.*, 2005; Jones; Mitchell, 2006; D'Andreamatteo *et al.*, 2015). Since that, the LH implementations have been multiplying, with emphasis on secondary or tertiary health levels, and expanded to countries such as Brazil and the Netherlands (Costa; Godinho Filho, 2016). Hospitals are the most exploited scenarios, and the emergency and surgery departments are the pioneers. The USA is the leading country in number of applications (D'Andreamatteo *et al.*, 2015). The theoretical studies analyzed by these authors (D'Andreamatteo *et al.*, 2015; Costa; Godinho Filho, 2016) mainly emphasized barriers, challenges, and success factors for the LH, considering the health sector as a whole. However, considering the economic and social significance of the Pharmaceutical Services (PS) operations, as expenses with medicines, are relevant and growing in the cost structure in the health sector, how have the LH practices been contributing to an improvement in PS operations?

According to Hlubocky et al. (2013), three waste sources are particularly important in the implementation of a change in the pharmaceutical practice model: errors related to medication, processing, and non-used potential of employees. The authors claim that such errors not only put patients at risk, but also result in time and resource waste.

Soliman and Saurin (2017) observed that the published studies are still focused on Lean applications at a tool level in specific departments or processes and not on organizational culture and strategy. They indicate that the Lean limitations in the health sector and the difficulties met in this new environment are still under investigation, as the Lean Healthcare is recent if compared to the Lean Manufacturing.

The objective of this study is to analyze the LH utilization in the context of Pharmaceutical Services activities. The theoretical contribution aims to widen the academic under-

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standing on the LH in PS, exploiting which practices, main metrics and results have been obtained in such applications or in their non-existence. The practical contribution is the identification of application opportunities, aiming to guide engineers, consultants, health professionals, and PS decision makers in their efforts to reduce the possible losses in the process and improve quality.

2. RESEARCH METHODOLOGY

A comprehensive literature review was performed on the databases SCOPUS, Web of Science, PubMed, and Embase in order to investigate the LH contribution to improve PS operations, using the keywords and the search strategy presented in Chart 1.

The acronym Pico (population, intervention, comparison, and outcome) was used to structure the search strategy from the elaboration of the survey question and the identification of the search terms (Higgins; Green, 2011; Shamseer *et al.*, 2015), thus generating the search strings described in chart 1.

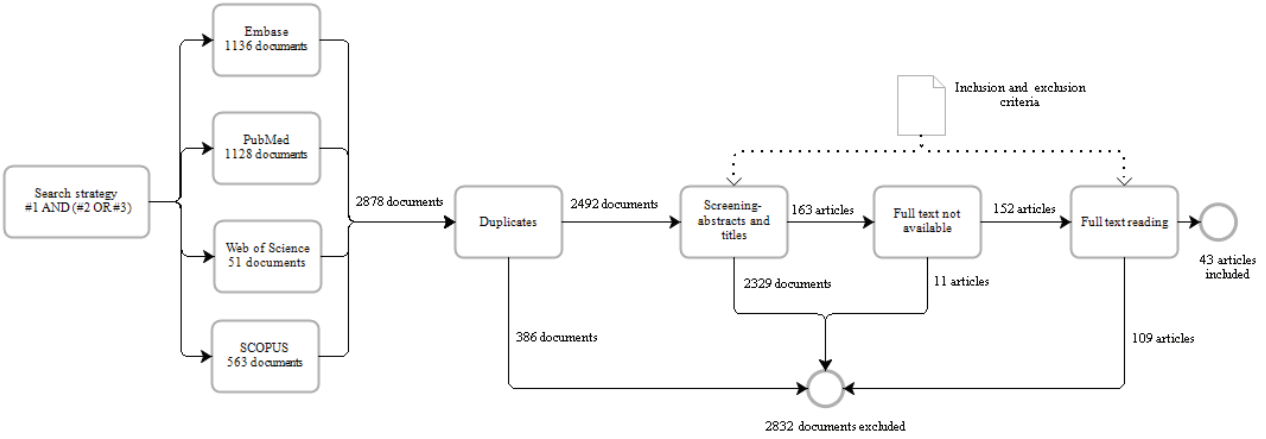
Articles on primary studies published in the last 10 years, until 2017, and presenting the application of Lean Healthcare in Pharmaceutical Services activities were selected. No article was excluded based on the outcomes of the LF applications in PS. Articles in Portuguese, English, Spanish, and French were considered. Duplicated articles, review articles, articles whose full content was not available and articles that, despite approaching an improvement in some activity related to Pharmaceutical Services, did not use the term "Lean" were deemed to meet the exclusion criteria.

The articles were compiled in an electronic spreadsheet using MS Excel® software, and were classified according to the application sector, the main PS operations, and the phase-related activity, when applicable. Then, the articles were analyzed with the intention to identify their theoretical contribution, methods, practices, and main used indicators, besides the results of such indicators.

Content analysis of the articles enabled the exploration of the tools and Lean practices that were studied in the several applications found. The original country of the study, the publication year, and the journal were used as context units. As analysis units, the articles were separated and grouped by tool type and method adopted, according to the healthcare level and to the Pharmaceutical Services activity to which they were related. This effort generated a comparative chart of the found techniques.

3. RESULTS

The search in the databases returned 2,878 documents. Figure 1 presents the result of the search in the databases and of the application of the inclusion and exclusion criteria. Duplicated articles were initially eliminated. Then, titles and



#	Search strategy
#1	"Lean" OR "Lean Healthcare" OR "Lean Manufacturing" OR "lean thinking" OR "lean management" OR "lean production" OR "lean practices" OR "Lean factors" OR "Lean approach" OR "lean methodology" OR "Six Sigma" OR "Sigma, Six" OR "Sigmas, Six" OR "Six Sigmas" OR "Lean Six Sigma" OR "Lean Six Sigmas" OR "Six Sigma, Lean" OR "Six Sigmas, Lean
#2	"Pharmaceutic Services" OR "Pharmaceutical Services" OR "Pharmaceutical Care" OR "Pharmacy Services" OR "Services, Pharmaceutic" OR "Services, Pharmaceutical" OR "Services, Pharmacy" OR "Care, Pharmaceutical" OR "Pharmaceutic Service" OR "Pharmaceutical Service" OR "Pharmacy Service" OR "Service, Pharmaceutic" OR "Service, Pharmaceutical" OR "Service, Pharmacy"
#3	"Pharmacy Distribution" OR "Distribution, Pharmacy" OR "Distributions, Pharmacy" OR "Pharmacy Distributions" OR "Community Pharmacies" OR "Community Pharmacy" OR "Pharmacies, Community" OR "Pharmacy, Community" OR "Pharmac$"
#4	#1 AND (#2 OR #3)

Figure 1. Flowchart of article selection and search strategy

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abstracts were read, thus applying the criteria for inclusion and exclusion. Finally, a full content reading enabled obtaining the final list of selected articles. It is stressed that 11 articles were excluded due to the impossibility of accessing their full content.

The list of selected articles is in Table 1.

The selected articles were published from 2008 to 2017, and an increase in the number of publications was verified in the more recent years. Such profile shows that the use of the Lean Healthcare in the Pharmaceutical Service context is relatively recent (Soliman; Saurin, 2017; D'Andreamatteo *et al.,* 2015).

It was verified that approximately 65% of the studies were performed in the United States (22 articles) or United Kingdom (six articles). This can be explained by the presence of incentive policies of governmental bodies or societies, as described below.

In the United States, the American Society of Health-System Pharmacists (ASHP) and the Foundation of Research and Education of ASHP co-sponsored the Pharmacy Practice Model Initiative (PPMI). The PPMI's objectives are updating the practice model structure to improve the patient's attendance and increase the amount of time that pharmacists spend in direct patient care functions. The initiative aims to aid by guiding hospitals and health systems to develop successful practical models. LH was indicated as a significant help to achieve such objectives (Hlubocky et al., 2013). In the United Kingdom, the National Health Service (NHS) incentivizes the incorporation of tools such as the value stream mapping (VSM) in the NHS units, including the pharmacies (Lindsay *et al.*, 2014; NHS, 2018)

Two studies were conducted in Brazil. The first one (Costa *et al.*, 2015) evaluated five sectors of two Brazilian hospitals that implemented LH concepts in their operations. The hospital pharmacy service was one of the analyzed sectors, aiming to improve stock management. The second identified Brazilian study (Furukawa et al., 2016) analyzed, by the Lean Six Sigma methodology, sustainable actions from the environmental point of view in medicine-related processes in the hospital context, from the receipt of the prescription by the Hospital Pharmacy to the waste disposal by the nurses, once the medicines are administered.

The selected articles were from 25 journals. The American Journal of Health-System Pharmacy was highlighted with eight published articles, which can be explained by being the official publication of the American Society of Health-System Pharmacists (ASHP), which incentivizes the LH use (Hlubocky et al., 2013).

Article classification

Figure 2, elaborated based on a Sankey diagram, presents the classification of the articles by sector, step in the Pharmaceutical Services cycle, and activity. Sankey diagrams are used to visualize flows of energy, materials, or other resources, with applications in several sectors (Schmidt, 2008). It is possible to verify that most articles are from the Hospital Pharmacy sector and approached the PS cycle stages of Distribution and Use and the Medicine Handling and Dispensation activities, symbolized by the larger thickness of the arrows in this figure.

A predominance of Hospital Pharmacy-related studies was verified, which is according to the studies by Andersen et al. (2014) and D'Andreamatteo *et al.* (2015), which claim that, in the health sector, the Lean is more disseminated in hospitals (secondary and tertiary healthcare levels). In such context, studies involving medicine distribution (20 articles) and use (26 articles) in the hospital environment were highlighted.

In medicine distribution, LH has been mainly used to improve the processes related to handling injectable medicines, highlighting chemotherapeutic drugs (Aboumatar *et al.*, 2010; Lingaratnam *et al.*, 2013; Beard et al., 2014; Sullivan *et al.*, 2014; Lamm *et al.*, 2015; Shah *et al.*, 2016). The LH application allowed reducing errors and waste (Lingaratnam *et al.*, 2013), the time to prepare a medicine (Aboumatar *et al.*, 2010; Lamm *et al.*, 2015), and the waiting time for patients (Beard et al., 2014), including the time to administer the first dose (Lingaratnam *et al.*, 2013). Other approaches include redesigning the medicine distribution against the increase in automation (Lindsay *et al.*, 2014) and applying the Toyota production system concepts aiming to improve safety and to reduce the time for the medicine distribution process (Newell et al., 2011). An approach more aligned with environmental sustainability was also verified, with the whole medication process being analyzed from the prescription reception by the Hospital Pharmacy to the waste disposal by nurses, focusing on waste management. As a result, a reduction in the quantity of chemical, infective, perforating and cutting waste generated was achieved, besides an increase in the quantity of common and recyclable waste (Furukawa et al., 2016).

There was a concentration of studies related to the medicine use step (25 articles), focusing on dispensation, which was approached in the attendance context in both hospitalization units (Al-Araidah *et al.*, 2010; Beard; Wood, 2010) and outpatient units (Jenkins; Eckel, 2012; Hunter *et al.*, 2013; Amerine et al., 2017). Such approaches intended to analyze aspects such as the time of the dispensation process cycle (Al-Araidah *et al.*, 2010; Beard; Wood, 2010; Declaye *et al.*, 2015; Elsheikh et al., 2017), waiting time for patients

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Table 1. List of selected articles

#	Author	Year	Journal	Country from which the data are collected
1	Mazur and Chen	2008	Health Care Management Science	United States
2	Davis et al.	2009	Hospital Pharmacy	United States
3	Hintzen et al.	2009	American Journal of Health-System Pharmacy	United States
4	Yamamoto et al.	2010	Quality Management in Health Care	United States
5	Yamamoto et al.	2010	Hospital Pharmacy	United States
6	Al-Araidah et al.	2010	Journal for Healthcare Quality: Official Publication of the National Association for Healthcare Quality	United States
7	Beard and Wood	2010	The Pharmaceutical Journal	UK
8	Aboumatar et al.	2010	Joint Commission Journal on Quality and Patient Safety	United States
9	L'Hommedieu and Kappeler	2010	American Journal of Health-System Pharmacy	United States
10	Newell et al.	2011	Journal for Healthcare Quality: Official Publication of the National Association	United States
11	Jenkins and Eckel	2012	American Journal of Health-System Pharmacy: AJHP: Official Journal of the	United States
12	Surendranath et al.	2012	International Journal of Current Pharmaceutical Research	India
13	Hunter et al.	2013	Journal of the American Pharmacists Association	United States
14	Lingaratnam et al.	2013	Journal of Oncology Practice	Australia
15	Jonny and Nasution	2013	2013 International Conference on Manufacturing, Optimization, Industrial and Material Engineering (MOIME 2013)	Indonesia
16	Beard et al.	2014	European Journal of Hospital Pharmacy	UK
17	Curatolo et al.	2014	Eur J Hosp Pharm	UK
18	Baril et al.	2014	Journal of Medical Systems	Canada
19	Sullivan et al.	2014	American Journal of Health-System Pharmacy	United States
20	Tilson et al.	2014	Hospital Pharmacy	United States
21	Lindsay et al.	2014	International Journal of Human Resource Management	UK
22	Prasetya et al.	2015	International Journal of Pharmaceutical Sciences Review and Research	Indonesia
23	Declaye et al.	2015	Eur J Hosp Pharm	Belgium
24	Facca et al.	2015	CSHP PPC 2015	Canada
25	Benfield et al.	2015	American Journal of Health-System Pharmacy	United States
26	Green et al.	2015	International Journal of Pharmacy Practice	UK
27	Lamm et al.	2015	American Journal of Health-System Pharmacy: AJHP: Official Journal of the American Society of Health-System Pharmacists	United States
28	Abuhejleh et al.	2016	BMJ Innov	United Arab Emirates (UAE)
29	Afonso et al.	2016	Eur J Hosp Pharm	Portugal
30	Nazar et al.	2016	BMJ Open	UK
31	Shah et al.	2016	Journal of Oncology Practice	United States
32	Furukawa et al.	2016	Revista Brasileira de Enfermagem	Brazil
33	Lefebvre et al.	2016	Pharmacien Hospitalier et Clinicien	France
34	Fisher et al.	2016	BMC Health Services Research	United States
35	Kieran et al.	2017	International Journal for Quality in Health Care: Journal of the International Society for Quality in Health Care	Ireland
36	Karel et al.	2017	American Journal of Health-System Pharmacy: AJHP: Official Journal of the American Society of Health-System Pharmacists	United States
37	Amerine et al.	2017	American Journal of Health-System Pharmacy	United States
38	Elsheikh et al.	2017	Business Process Management Journal	Saudi Arabia

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39	Goga et al.	2017	Consultant Pharmacist	United States
40	Shiu and Mysak	2017	Canadian Journal of Hospital Pharmacy	United States
41	Costa et al.	2017	The International Journal of Health Planning and Management	Brazil
42	Kinney et al.	2017	Hospital Pharmacy	United States
43	Monreal et al.	2017	Farmacia Hospitalaria	Spain

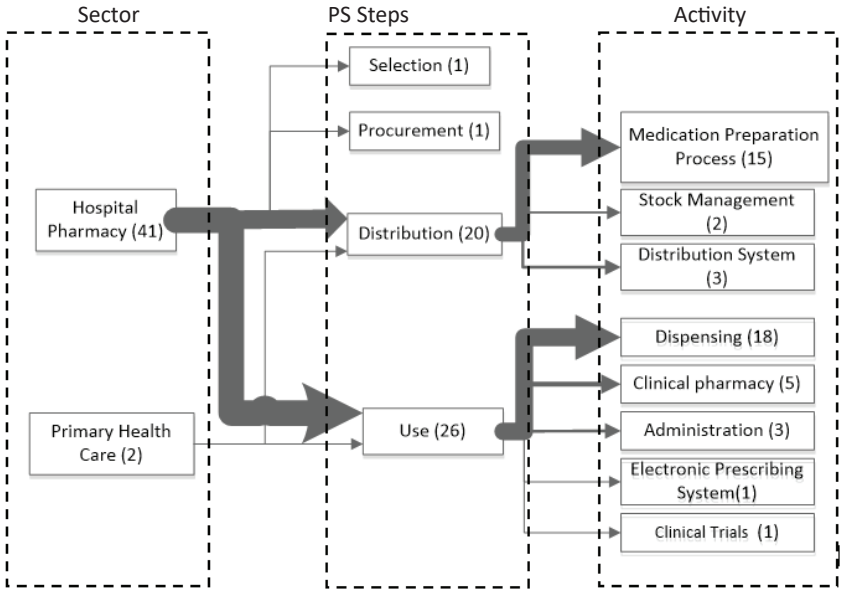

Figure 2. Article distribution according to acting areas, Pharmaceutical Service cycle steps, and analyzed activity – Sankey Diagram

(Hunter *et al.*, 2013; Beard et al., 2014; Abuhejleh et al., 2016; Amerine et al., 2017), and reduction in waste and elimination of activities that do not add value (Mazur; Chen, 2008; Jenkins; Eckel, 2012; Nazar *et al.*, 2016).

Referring to the waste and elimination of activities that do not add value, the focus given to the performance of the pharmaceutical professional is highlighted. Jenkins and Eckel (2012) managed to reduce by 47% the time spent by pharmacists on less complex technical activities, thus increasing the time spent on activities focused on direct contact with patients. Other studies also show that pharmacists spend a significant part of their time in activities that do not add value, in a magnitude of 23.8% (Green *et al.*, 2015), 25% (Curatolo *et al.*, 2014), and 40.3% (Fisher *et al.*, 2016). For example, Curatolo *et al.* (2014) report waste referring to: overproduction related to reworking to rewrite the information provided by the medical team; waiting, as pharmacists spend 5% of their time waiting for answers from the nursing team; non-utilized staff intellect, as pharmacists spend 12% of their time in the infirmary, checking patients' medicines and writing order forms that can be filled by a technician; transportation, as pharmacists spend 5% of their time transferring forms to the Hospital Pharmacy dispensary; and motion, as pharmacists spend 2.5% of their time in the infirmary looking for patients' medicine tables or medicines. The author agrees that the LH helps to identity such waste and that professionals' acting must be focused on activities that add more value, such as clinical pharmacy (Curatolo *et al.*, 2014; Green *et al.*, 2015; Fisher *et al.*, 2016).

LH use in clinical context was verified by Goga *et al.* (2017), whose objective was to decrease the prescription of antipsychotic drugs indicated for agitation. The authors inform that a multidisciplinary team succeeded in reducing such indication in 90% by using the LH. The intervention performed by using the LH produced cultural changes in the working team, as they learned to wait for a full patient evaluation, instead of automatically administering an antipsychotic drug on the patient's first day of hospitalization.

LH was also used focusing on the medicine administration process. Kieran *et al.* (2017) applied the LH aiming to improve the drug round efficiency, thus reducing interruptions, and to reduce the time needed to complete

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the oral drug round. The Hospital Pharmacy, nursing and quality improvement staff participated in such intervention, obtaining significant results, which can be seen in Chart 3.

The waste in the medicine procurement process was approached by a single study conducted at the Hospital Pharmacy service of a hospital in Indonesia, which was based on the seven wastes of the Lean. The authors identified the following causes: poor communication, unplanned drug procurement budget, inappropriate inventory, organizational functions of the Pharmacy and the Therapeutic Commission not yet administered, and inadequate working area structures (Prasetya et al., 2015).

A study reported the LH application in the medicine selection step in PS. The authors applied the Lean methodology in an initiative to redesign the continuously updated list of medications available for use within an academic medical center (Karel *et al.*, 2017).

Use of lean healthcare tools and practices

Referring to the LH tools and practices cited in the articles, the value stream mapping (VSM) is highlighted as the most used, which was also reported by other authors (Henrique; Filho, 2018). When applying VSM to analyze the medicine distribution process for urgent orders in a general hospital in Portugal, Afonso et al. (2016) identified several tasks with little or none added value.

It is interesting to verify that, in second place, 11 articles cited the use of workflow analysis in the studies. Sullivan *et al.* (2014) developed two workflow maps for medication order processing for Yale-New Haven Hospital outpatient oncology clinics, before and after Lean process improvements. The change consisted in eliminating six steps, with four being developed by pharmacists and two being developed by technicians.

The study performed by Mazur and Chen (2008) is highlighted by developing a system mapping and analysis method based on VSM principles. The method was applied aiming to understand and reduce the medication delivery waste in the hospital context.

The practices and tools presented in Table 2 aid the conduction of future empirical studies, especially those intending to exploit the ones that were less used, aiming to prove or not their value in such research field.

Table 2. Tools and practices cited in the selected articles

Tools and practices cited in the articles	Times cited	Percentage
Value stream mapping	16	17.0%
Workflow analysis (direct observation)	11	11.7%
5S	8	8.5%
Kaizen	7	7.4%
Chrono analysis	7	7.4%
Process mapping	6	6.4%
Ishikawa diagram	5	5.3%
5 Whys	5	5.3%
Kanban	5	5.3%
FMEA	4	4.3%
A3	3	3.2%
Visual management	3	3.2%
Standardization of work	2	2.1%
Impact effort matrix	1	1.1%
Impact analysis	1	1.1%
Focal groups	1	1.1%
Workshop	1	1.1%
Brainstorming	1	1.1%
System mapping and analysis method	1	1.1%
Poka yoke	1	1.1%
Spaghetti diagram	1	1.1%
Dashboard	1	1.1%
Just-in-time	1	1.1%
5-minute meetings	1	1.1%
Interviews	1	1.1%
Total	94	100%

In the study of D'Andreamatteo *et al.* (2015), they found that the transfer of several quality improvement techniques, such as Lean Six Sigma, from the manufacturing industry to the service industry (such as health) would represent an opportunity for the organizational systems and health practices to objectively improve the value of the care they provide.

Metrics used in the studies

Table 3 presents the results of the main metrics that show the improvement provided by the use of Lean Healthcare in the Pharmaceutical Services context. The result column expresses the percentile between the value obtained before and the one obtained after the intervention. Some studies presented qualitative indicators or only performed a diagnosis, not presenting a result after an intervention was implanted. This is the case of Curatolo *et al.* (2014), Green *et al.* (2015) and Fisher *et al.* (2016), which presented a profile of the ratio between the time dedicated to activities that add value and the one dedicated to activities that do not add value, without comparing the variation of such times before and after an intervention. Karel *et al.* (2017) and Lindsay *et al.* (2014) are examples of articles

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that used a more qualitative approach. The former analyzed the application of the Lean methodology in an initiative to redesign the formulary maintenance process used in the Pharmacy context and Therapeutics Commission at an academic medical center, reporting that the changes contributed to a safer and more efficient workflow. In turn, Lindsay *et al.* (2014) analyzed the experience of the employees after the implantation of a more automated process to distribute medicines in a hospital.

The analysis of the articles has allowed identifying three large variable categories that were quantified in the studies: activities that do not add value, waiting time, and dispensation cycle time. Satisfaction metrics of both the work team and the patients/customers were mentioned in lesser extent.

The identification and elimination of the activities that do not add value are part of the Lean's bases. Some studies were limited to identify and quantify the percentile of time dedicated to such activities, reporting ratios such as 23.8% (Green *et al.*, 2015), 25% (Curatolo *et al.*, 2014), and 40.3% (Fisher *et al.*, 2016). The interventions elaborated with the LH support obtained relevant reductions in the time dedicated to activities that do not add value, with reductions of 60% (Prasetya et al., 2015) and 74% (Jenkins; Eckel, 2012). It is noteworthy that, specifically in the case of Pharmaceutical Services activities, one of the main reasons to eliminate losses is the intention to increase the time dedicated by the pharmaceutical professional to activities directly related to the patient, such as clinical pharmacy. This was one of the PPMI's objectives and has been reported in the articles as being one of the justifications (Jenkins and Eckel, 2012; Fisher *et al.*, 2016). In their literature review, D'Andreamatteo *et al.* (2015) indicate productivity and cost-efficiency as a category predominantly found in the studies.

The waiting time for the patient to receive the medicine is another aspect that is highlighted in the quantification of the benefits in using the LH in the Pharmaceutical Services context. Reductions from 27% (Hunter *et al.*, 2013) to 90% (Abuhejleh et al., 2016) were reported. Similarly, other articles have quantified the time for the medicine dispensation cycle, comprising the time between the medicine order and the reception or administration to the patient. The reductions in this indicator ranged from 17% (Elsheikh et al., 2017) to 86% (Beard; Wood, 2010).

Most analyzed LH applications are tool applications in some process with analyses before and after the application. Despite the proven benefits in applications, there is still a need for an approach that proves the incorporation of LH as an organizational strategy and as a culture of continuous improvement, as it was also verified by Soliman and Saurin (2017).

Kovacevic *et al.* (2016) argued that the lean implementation in the health area could be more difficult than in the standard industrial environment and that there are a significant number of Lean projects in health that did not obtain measurable results and sustainable benefits. This reinforces the need for deepening the investigations in this area.

4. FINAL CONSIDERATIONS

The analyzes performed in this investigation enables us to confirm that the lean thinking applied to the Pharmaceutical Service is a relevant research subject, presenting a reduced volume of published works and a relatively recent application, with a stronger growth in recent years. The Lean Healthcare utilization in the Pharmaceutical Service context is focused on the hospital sector and on the Distribution and Use steps of the PS cycle, especially on medicine handling and dispensation activities.

The low quantity of studies addressing LH in the PS context at the primary healthcare level, as well as studies approaching LH in Selection and Procurement steps of PS, regardless of the healthcare level, is highlighted. The identified studies enable the visualization of the benefits of such application.

The analysis of the articles gathered in this investigation reinforced the LH relevance in improving the Pharmaceutical Services operations, thus contributing to reducing the waste of time and resources and increasing the safety and efficiency of the processes. This is particularly important for countries whose resources are limited, as in the current Brazilian context. However, the applications found consisted in one-off interventions, not ensuring that the LH is widely and consistently present in the organizations.

It was evidenced that the LH is an important tool in the context of pharmaceutical care, as it helps to eliminate activities that do not add value, thus allowing the pharmacist to be more dedicated to activities directly related to the patient care.

The predominance of studies from the United States and the United Kingdom reinforces the significance of actions to foster and spread lean thinking in the health sector, as these countries have presented such profile as a result from coordinated actions to stimulate the use of LH.

This review has broadened the academic understanding about the LH, thus exploiting its application in the PS context. Under the practical point of view, opportunities were identified for future applications. The metrics and tools compiled were indicated and they can stimulate PS managers and decision-makers to apply the LH.

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Table 3. Main metrics used to evaluate the interventions implemented in the selected articles

Author	Main metrics used to evaluate	Result
Kieran *et al*. [58]	Mean time to administer medicines	reduction of 59%
	Interruption in medicine administration	reduction of 75%
Yamamoto *et al*. [66]	Patients with blood glucose out of the normal limits	reduction of 12%
Yamamoto *et al*. [13]	Loss reduction and reworking	sparing US$ 75,000.00
Prasetya *et al*.[59]	Time of activities that do not add value	reduction of 60%
Karel *et al*. [60]	Work process safety and efficiency	Qualitative study: It reports that changes stimulate a safe and efficient workflow.
Abuhejleh *et al*. [51]	Waiting time for the patient	reduction of 90%
	Percentile of patients with improvement in clinical conditions	increase of 69%
Afonso *et al.* [62]	Time spent by pharmacists in activities that do not add value	Qualitative study: It reports that several activities that do not add value or that present a low value addition were identified.
Al-Araidah *et al.* [44]	Time of the medicine dispensation cycle	reduction of 48%
Amerine *et al*. [46]	Waiting time for the patient	reduction of 67%
Beard and Wood [45]	Time of the medicine dispensation cycle	reduction of 86%
Declaye *et al*. [49]	Time of the antiseptic provision cycle for the infirmaries	reduction of 54%
Elsheikh *et al*. [50]	Time of the medicine dispensation cycle for inpatients	reduction of 17%
	Time of the medicine dispensation cycle for the emergency sector	reduction of 80%
Facca *et al*. [72]	Number of interruptions during the process	reduction of 43%
	Number of independent double-checks	increase of 10%
Hunter *et al*. [47]	Waiting time for patients	reduction of 27%
	Customer's satisfaction	increase of 13%
Jenkins and Eckel [48]	Time spent by pharmacists in activities that do not add value by prescription	reduction of 74%
Nazar *et al.*[52]	Number of steps needed in the process	reduction of 30.4%
Shah *et al*. [41]	Rate of prescriptions reviewed by the pharmacist	increase up to 100%
Aboumatar *et al*. [37]	Mean time required to prepare a chemotherapeutic medicine	reduction of 9% (with reduction of 50% in the standard deviation value)
	Number of phone calls attended by the pharmacist that is handling the medicine	reduction of 83%
Furukawa *et al*. [35]	Daily quantity of chemical, infective, perforating and cutting waste per patient	reduction of 26%
	Daily quantity of common recyclable waste per patient	increase of 24%
	Daily quantity of non-recyclable common waste per patient	increase of 20%
Beard *et al*. [38]	Mean time to attend a prescription for an inpatient	reduction of 86%
	Daily percentile of patients with delays in the chemotherapeutic drug provision	reduction of 92%
Benfield *et al*. [73]	Mean number of dispensed units	increase of 5%
L'Hommedieu and Kappeler [67]	Number of dispensed units	increase of 23%
	Loss rate in the dispensed units	decrease of 8%
	Annual expense with medicines	reduction of 2.6%
Mazur and Chen [53]	Savings generated with loss reduction	US$ 10,775.00 (representing about 3% of the operational budget of the Hospital Pharmacy)

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Lefebvre *et al.* [74]	Customer's satisfaction	Qualitative study: It reports that the satisfaction results for the work team were positive and that the survey did not approach the patients.
	Revision and creation of new documents and performance indicators	Twelve documents were revised and 22 were created; 24 waste-related issues were identified and the key performance indicators were revised.
Curatolo *et al.* [55]	Ratio between times dedicated to activities that add value and activities that do not add value	It is not compared after the intervention. 25% of activities do not add value.
Fisher *et al.* [56]	Ratio between times dedicated to activities that add value and activities that do not add value	It is not compared after the intervention. 40.3% of activities do not add value.
Goga *et al.* [57]	Number of orders for antipsychotic drugs indicated for agitation	reduction of 90%
Green *et al.* [54]	Percentile of activities classified as waste	It is not compared after the intervention. 23.8% of activities do not add value.
Shiu and Mysak [75]	Lead time	reduction of 7%
	Time dedicated to activities that add value	Increase of 1% (increase of 31 min/day for each pharmacist to act in the patient care)
Costa *et al.* [34]	Total cost of the stock products	reduction of 20%
Baril *et al.* [70]	Time to prepare medicines	reduction of 92%
	Time to distribute medicines	reduction of 6%
Davis *et al.* [64]	Number of sterile product lots produced daily	increase of 250%
	Time for delivering the first dose	reduction of 50%
	Number of medicine stocking places in the auxiliary units	reduction of 60%
Kinney *et al.* [76]	Time to meet the requests	reduction of 68%
	Internal errors identified and corrected by the pharmacist	reduction of 93%
	Reduction in the need for procurement	saving of US$ 78,000.00
Lamm *et al.* [39]	Mean time to prepare the chemotherapeutical medicines	reduction of 57%
Lingaratnam *et al.* [40]	Waiting time for the patient	reduction of 38%
	Time for releasing the first dose	reduction of 28%
	Medicine loss by expiry or reworking	reduction of 76%
Jonny and Nasution [69]	Lead time	reduction of 33%
Sullivan *et al.* [42]	Time for the pharmacist to analyze the chemotherapeutic drug order	reduction of 33%
	Time for verifying the chemotherapeutic medicines	reduction of 52%
	Time for releasing the chemotherapeutic medicines	reduction of 47%
Surendranath *et al.*[68]	Time for releasing the first dose	reduction of 50%
	Medicine loss by expiry or rework	reduction of 64%
Tilson *et al.*[71]	Losses in the manufacturing of sterile products	decrease of 50%
Hintzen *et al.* [65]	Medicine loss in the handling process	reduction of 74%
	Total value of stock medicines	decrease of US$ 50,000.00
	Medicine loss by expiry	reduction of 20%
Monreal *et al.* [77]	Total number of alerts in the electronic prescription system	reduction of 28%
	Number of false-positive alerts in the electronic prescription system	reduction of 25%
Lindsay *et al.* [32]	Employees' experience	Some employees reported new commitments to learning and providing collaborative services "closer to the patient", while others complained about less opportunities alternating among several functions
Newell *et al.* [43]	Medicine return from the infirmaries to the Hospital Pharmacy	reduction of 60%
	Nursing team's satisfaction	increase of 29%

Among the opportunities for future investigation, the following topics may be highlighted: i) identifying the relevance of using the LH in the context of the PS Selection and Procurement steps, poorly approached in the papers analyzed; ii) selecting the LH tools and practices that are more applicable in this study context; iii) understanding the LH impact on PS operations that are not related to the hospital context, especially those related to basic healthcare; iv) proposing metrics to evaluate the LH impact on processes and persons in the PS context; v) identifying cases where the LH is presented as a settled approach and not only a one-off application in the PS context, in order to identify the long-term benefits; and (vi) fostering the strategic implementation of LH in PS.

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